THE

Indian Tea Association.

SCIENTIFIC DEPARTMENT

QUARTERLY JOURNAL.

PART IV.

1924.

Calcutta:
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(Photo by H. W. CAVE & CO., Ceylon).

A Tea Factory in Ceylon.

TEA IN CEYLON.

BY

C. R. HARLER.

Some explanation and apology is perhaps necessary for the comprehensive title, Tea in Ceylon, which is given to this article. A discussion of tea in Ceylon, however brief, is outside the scope of this paper which is merely a record of notes made by the writer during a short visit to the Island. The observations made are naturally those concerned with the marked differences between certain aspects of the tea industry in Ceylon and North East India.

A four-hour journey from Colombo takes one to Kandy, a distance of about 74 miles, and Hatton, the centre of the tea area, is less than seven hours from Colombo. Badulla, at the extreme end of the tea district, is only a fourteen-hour journey, a distance of 180 miles. Contrast this with the 48-hour journey to Dibrugarh, the premier tea district of Assam, 700 miles from Calcutta. The tea gardens nearest to Calcutta are in the Terai or South Sylhet, both districts being about 300 miles from the business centre of the industry.

The excellence and number of roads in Ceylon are matters for remark to a person coming from Assam. The journey from Colombo to any of the tea districts can be made by road even more quickly than by train.

Each planting district has its own telephone system which together with the network of roads has influenced the course of the development of the industry in certain respects. Thus at a convenient centre for each district, Colombo engineering firms have opened workshops, which are conducted by Europeans. If any of the tea machinery requires expert attention, a telephone call brings an engineer to the estate in a very short time. In Assam, cut off as many gardens are during the rains, it is usual to have an engineer resident on the garden.

During the train journey from Colombo to Badulla a good idea of the general lie of the land in the planting districts is obtained. For the first fifty miles or so the railway runs through rice land, not absolutely flat as are the plains of Bengal but with the monotony broken by small hillocks of red soil such as occur in Cachar. The rice land soil is usually red and quite different from the greyish alluvium met in North East India. The lower hill slopes are beautifully terraced for rice cultivation.

Soon after the line begins to rise the planting district is entered and cocoanut, cacao, rubber, cardamoms and various other crops are seen growing, another contrast to the Assam Valley where little but rice and tea are seen. Kandy is situated at an elevation of 1,600 feet and as this town is approached tea becomes more and more frequent. In the Kandy district it is common for a planter to have charge of an estate on which three or even more crops are grown.

Above Kandy the line runs through a series of narrow valleys occupied almost wholly by tea. About Nawalapitiya the last rubber is seen and thence onwards the hill slopes, right to the crests, are generally covered with tea bushes. Many of the hill sides seem to be little more than rock with tea bushes perched on small patches of soil. In many places precipitous slopes are planted with tea but the bushes here suffer from lack of soil as a rule.

The Dikoya district through which the railway runs is one which was formerly under coffee and the tea was planted up on partially exhausted and considerably washed soil. Many of the factories are relics of the coffee days and are situated at the bottom of the valley in order to utilise the water power. Since many gardens are put out over a range of 2,000—3,000 feet the factory may be either in a comparatively warm, damp valley or on an open hill side. The quality of the tea made is poorer in the lower factories, but on the other hand water power is available. In the Dikoya district there are about 40,000 acres of tea.

The Dimbula district is the finest tea district in Ceylon and adjoins Dikoya. Much of the land here is above 4,000 feet and

the nature of the vegetation is different from that in lower elevations. On the tea estates the most notable change is the substitution of Acacia shade trees for the dadap. In the Dimbula district there are about 50,000 acres of tea.

From Nanu Oya a narrow gauge line runs to Nuwara Eliya and on through Kandapola to Ragalla. These districts are very fine and contain some of the highest estates in Ceylon. At present no jungle area above 5,000 feet is granted by the Government for tea land, but much of the tea already planted is above this altitude and some is put out at about 7,000 feet. This is higher than most of the tea in the Darjeeling district.

Continuing on the main line from Nanu Oya we pass Pattipola, the highest point on the railway, 6,225 feet. It is about here that the *patanas* or grassy downs of the Uva district are entered.

It is a remarkable experience to enter the Pattipola tunnel in June or July when the south-west monsoon is beating against the mountain side, and in a few seconds to run into brilliant sunshine on the other side of the Island divide, with the *patanas* stretching away into the distance.

In Uva about 40,000 acres of tea are put out and in this area served mainly by the north-east monsoon, the planting season differs from that on the south-west side of the Island.

The low grown tea is planted on the south-western or wet side of the mountains, the chief district being the Kelani Valley. During the rubber boom in 1910 much of the tea was interplanted with rubber which has since practically stifled the tea. Although the tea in these areas is called " low grown " nothing approaching the flat stretches of tea common in North East India is seen. The planted area consists of hillocks often as steep and as rocky as the slopes in the high country.

Statistics.

In 1875 coffee was the chief crop of Ceylon. About this time the coffee bush was attacked by a leaf disease, the danger

of which was only realised after it had spread throughout the country and had got beyond control. In a few years the coffee acreage was reduced from 300,000 to 50 until the industry ceased to be in Ceylon. Following this failure, cinchona was planted but after a few years, owing to overproduction and competition from Java, this crop was no longer a paying one.

Tea was first planted in the sixties and in 1875 about a thousand acres were put out. The subsequent development is shown by the following figures :—

1875	... ...	1,080 acres planted.
1895	... ...	305,000 ,, ,,
1905	... ...	390,000 ,, ,,
1915	... ...	402,000 ,, ,,
1920	... ...	400,000 ,, ,,

There was some decrease in the area planted after about 1895 following on a period of over production. The present area put out under tea in full bearing is about 403,000 acres.

With the planting of rubber much of the tea in the lower areas was uprooted or deteriorated under rubber but this was compensated for by fresh areas opened out in the higher elevations. At present it is thought that the tea acreage has reached its limit although there is still much *patana* land available for planting.

The total area under tea in India is 707,700 acres distributed as follows :—

Assam	... ...	412,500 acres.
Bengal	... ...	185,400 ,,
Southern India	....	91,900 ,,
Northern India	...	15,800 ,,
Bihar and Orissa	...	2,100 ,,

Assam includes the Surma and Brahmaputra Valleys. Cachar and Sylhet, which comprise the Surma Valley, account for about 58,000 and 87,000 acres respectively. In the Assam or Brahmaputra Valley there are almost 267,000 acres under tea

of which more than 56,000 acres are in Darrang and about 99,000 acres in Sibsagar and 94,000 acres in the Lakhimpur districts.

Bengal includes the Dooars, the Terai, Darjeeling and Chittagong. Of the 185,400 acres of tea in this province, more than 115,000 acres are in the Dooars, about 46,000 acres in Darjeeling, about 19,000 acres in the Terai and 5,000 acres in Chittagong.

In Ceylon most of the tea is situated above 3,000 feet. Tea in the Kandy district is called " medium-grown " and that above about 4,000 feet is called " high-grown." More than 37 per cent. of the Ceylon tea is in the Kandy district, 23 per cent. in Nuwara Eliya and 18 per cent. in Badulla. Less than 20 per cent. is put out in low country. This state of affairs is very different from that in North East India where practically all the tea is at about sea level. Thus Dibrugarh in the Lakhimpur district, at the head of the Assam Valley and 1,000 miles from the sea is only 340 feet above the sea level. This altitude is probably about the average for all the tea in Assam. In Bengal many of the Dooars gardens rise to about 1,000 feet and some to 2,000 feet whilst the Darjeeling gardens vary in height from a little over sea level to about 7,000 feet.

The average size of a tea garden in North East India is 488 acres and in Ceylon it is 327 acres.

The yield varies widely in different districts both in North East India and Ceylon. In Ceylon the average yield for 1923 was about 434 lbs. per acre. The yield varies from about 700 lbs. in the low country to 300 or 400 lbs. in the high grown estates.

In North East India the crop has fluctuated greatly during the last two or three years owing partly to restricted plucking after the tea slump in 1920 and, later, to labour shortage. In 1923 the best yielding district was Lakhimpur giving 722 lbs. tea per acre. This was followed by Darrang giving 613 lbs., Sibsagar 592 lbs., Sylhet 564 lbs. and Cachar 535 lbs. The

Dooars averaged 574 lbs. and Darjeeling including the Terai, 430 lbs. per acre in 1923. Over the whole of North East India the 1923 crop averaged about 542 lbs. per acre.

In 1919, the year of maximum out-put in Ceylon, the crop averaged about 520 lbs. per acre. In 1915 the heaviest year in Assam the crop rose to about 680 lbs. per acre and in 1919 a record yield of 740 lbs. per acre was obtained in the Dooars.

The prices of Indian and Ceylon teas are of interest. Thus in 1923 the average Home sales showed the following :—

Northern India	...	1*s.* 6.76*d.*
Southern ,,	...	1*s.* 6.14*d.*
Ceylon	...	1*s.* 7.38*d.*

The prices of Ceylon teas vary according to elevation and season. The highest values are obtained in January, September and October and the lowest in June and November. The prices of the high grown teas average from 10 to 30 cents (2*d.* to 5*d.*) better than the medium and low grown teas on the Colombo market. The low grown teas generally bring a slightly higher price than the medium grown because they are better made.

In North East India the highest prices naturally go to Darjeeling teas. The next best teas are those of Assam followed by the Dooars then by Cachar and Sylhet. An idea of the present relative values is given by the figures for the 1923-24 season although these values are quite different from those shown in years before the present boom, which tends to equalization of price for good and poor grades alike.

Darjeeling ...	...	1*s.* 8.24*d.*
Assam ...	...	1*s.* 7.10*d.*
Dooars ...	...	1*s.* 5.71*d.*
Cachar and Sylhet	...	1*s.* 4.60*d.*

During the season under consideration Darjeeling accounted for 7.3 per cent. of the crop, Assam 57 per cent., the Dooars 17 per cent. and Cachar and Sylhet 18.7 per cent.

The Climate of Ceylon.

Ceylon lies about 7 degrees north of the Equator and partly on this account its climate varies less than that in most parts of India. The mean temperature varies but little at individual stations throughout the year and there are no long periods of drought except in the northern and eastern parts of the Island which are outside the planting districts.

The year may be divided into four seasons, the two monsoon periods and the intermediate periods.

Situated near the Equator as Ceylon is, the prevailing wind would be the north-east trade, blowing steadily throughout the year but for the disturbing influence of the land mass of Asia. In April and May the central Asiatic plateau warms up and there is a general air movement from the south to the north which increases till it eventually overcomes the trade wind and the south-west monsoon begins to blow. This wind, laden with moisture, deposits rain on the south-west side of Ceylon. The north and east of the Island lying in the leeway of the monsoon experience a comparatively dry period during April, May, June and July.

The monsoon sweeps round the Bay of Bengal and reaches Northern India about a fortnight later than Ceylon. The southern half of the Madras Presidency receives little rain from this source.

In July the attraction towards central Asia begins to weaken and an intermediate period of atmospheric equilibrium follows during which time local rain falls in Ceylon.

In October the wind begins to flow from the north into the now warmer latitudes near the Equator. In Assam the air flows from the Gobi desert of Tibet as a dry, cold wind which as it blows across the Bay of Bengal is warmed and picks up moisture. The trade wind which has previously been extinguished by the south-west monsoon is now reinforced and blows strongly against the eastern side of Ceylon where it is known as the north-east

monsoon. This monsoon blows from October to January after which comes the second period of equilibrium.

The following table illustrates the points put forward above. The stations chosen are those showing clearly the various seasons. In addition, the monthly rainfall at typical stations in the North East India tea districts is given.

Average monthly Rainfall at various Stations in Ceylon.

	Colombo.	Ratnapura.	Kandy.	Nawalapitya.	Nuwara-Eliya.	Badulla.
	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
January	3·36	5·33	5·22	8·22	5·65	9·71
February	1·84	4·36	2·23	3·65	2·03	3·02
March	4·30	8·58	3·86	5·11	3·32	4·34
April	9·67	12·54	6·78	7·90	5·66	7·46
May	10·73	17·64	5·43	13·84	6·64	4·45
June	7·20	19·96	9·64	65·81	12·85	2·29
July	4·48	12·86	7·50	38·54	12·07	1·99
August	3·14	11·93	5·69	39·64	7·91	3·22
September	4·73	14·96	5·93	40·67	8·29	3·37
October	13·44	18·85	11·80	24·57	11·13	9·88
November	11·59	14·34	10·57	16·43	9·00	10·45
December	5·11	8·77	9·12	6·62	8·57	12·43
TOTAL ...	79·59	150·03	83·77	271·00	93·12	72·61

Average monthly Rainfall at various Stations in North East India.

	Assam Valley (Tocklai).	Surma Valley (Silchar).	Dooars (Newlands).
	Ins.	Ins.	Ins.
January	0.56	0·64	0·43
February	1·45	2·32	1·54
March	3·51	7·93	2·54
April	9·18	13·56	8·30
May	9·35	15·72	22·31
June	14·43	20·39	42·14
July	15·82	19·98	44·96
August	14·24	18·69	31·82
September	10·64	13·95	26·40
October	4·33	6·40	5·90
November	0·65	1·31	0·27
December	0·38	0·54	0·14
TOTAL ...	79·18	121·43	187·39

At Colombo and Ratnapura both monsoons are distinctly marked although Ratnapura, with a back-ground of hills receives much more rain than Colombo. After the weakening of the south-west monsoon the precipitation again increases to a maximum in October which increase is usually attributed to the advent of the north-east monsoon.

Kandy, occupying a central position in the Island and not cut off on either side by high mountains, gets a fairly evenly distributed rainfall in addition to generous precipitations from both monsoons.

Nawalapitya is in the wettest area, being at the optimum altitude for rainfall (about 4,000 feet), and receives an average of 271 inches.

Nuwara Eliya escapes the full effect of both monsoons yet it is liberally treated by both.

Badulla, in Uva, is on the east side of the rain divide and receives most of its rainfall from the north-east monsoon. The effect of the rain divide is well demonstrated from Haputale. During the south-west monsoon, the cloud bank can be seen rolling up to the hill summit and just spilling over into the Uva district. As the clouds descend they disappear owing to the warming of the air by compression. On some estates, *e.g.*, Warwick at Ambawella, which are put out actually on the rain divide a walk of a mile or so may well take one in and out of the monsoon several times.

A comparison with the rainfall in Assam and the Dooars is of interest. The five-month drought from November to March accounts for the differences in the system of cultivation in North East India from that in Ceylon.

Ceylon does not experience such a wide range of temperature as does Assam. The annual mean temperature at Ratnapura is 80°F, at Kandy (1,654 feet) it is 74.4°F, at Nuwara Eliya (6,188 feet) it is 59.2°F, and at Badulla (2,225 feet), in Uva, it is 73.7°F. There is practically no change in the mean throughout

the year but the maxima and minima vary somewhat. These temperatures may be contrasted with those of North East India where the mean in July, the hottest month all over the tea districts, is about 83°F, and in January, the coldest month, the mean drops to 65°F in the Surma Valley, 61°F in the Dooars and 60°F in the Assam Valley.

In Ceylon, as in India, the bushes begin to flush, without the stimulation due to plucking, with the Spring rains. The heaviest flushing months all over the Ceylon tea districts both in the south-west and the north-east monsoon areas are March, April and May. During the first six months of the year many estates make two-thirds of their crop. In June, July and August, during which time the monsoon blows hard and the rain falls in torrents, the crop is poor. An idea of the great difference in the size of the crop throughout the year is given by the fact that on one estate the out-turn of finished tea in April was 130,000 lbs. out of a total crop of 800,000 lbs. The July crop was 60,000 lbs. After August the crop increases to a second maximum in November. December, January and February are again poor months in the south-west area although in Uva, November, December and January are good months, owing to the north-east monsoon rain.

In Assam the bushes are tipped in March or April or sometimes even earlier. The first real flush comes in May and the second in June. The big months are July, August and September. October is a fair month. November gives one, or may be two, good pluckings if the rains hold good. From December till the Spring tipping the bushes are not plucked.

Now our heavy flushing period corresponds with a combination of high temperature and humidity (both relative and absolute) which is the characteristic of monsoon conditions. In Ceylon the most humid months are not the best cropping months.

In our cold, dry season for four or five months although the temperatures approximate to those of Badulla and Nuwara Eliya

the bushes do not flush or but too slowly to be worth plucking. Rainfall which coincides with high temperature and humidity, is the controlling factor in tea crop production in North East India.

So far as other climatic factors are concerned there are several notable differences between Ceylon and Assam. Hail seldom falls in Ceylon and when it does there is practically no damage done as is the case in North East India. Ceylon is outside the range of cyclones although strong winds are common. The south-west is a steady, strong wind which necessitates wind belts and often strips bushes of their foliage. The higher tea districts of Ceylon experience frosts which, if severe, may blacken the leaf on the bush, but it is said that a frost during manufacture puts quality into the tea.

In Assam there are two quality periods. The first is with the June or second flush when all the qualities are fully developed and there is an abundance of "tip." During the rains there is a general falling off in quality all over North East India, but with the first cool breezes towards the end of September quality appears again and this is followed by the Autumn flavour.

In Ceylon a dry wind is said to give pungency and flavour. The teas are generally poor all over the Island during the rush months of March, April and May, then, in Uva, comes the flavour period with the south-west monsoon which blows dry in this province. Uva teas are poor in quality during the humid period of November, December and January when the north-east monsoon is blowing, whilst the Nuwara Eliya district gives flavouring teas in January, for the north-east monsoon blows dry in this district. The quality periods naturally vary from year to year with climatic conditions.

Flavour depends not only on the leaf but also on manufacture and it has been observed that in factories where a good natural wither is obtainable, it is easier to make good teas than in factories less favourably situated.

PERADENIYA.

At Peradeniya, four miles from Kandy, are situated the Royal Botanic Gardens in a loop of the Mahaweli Ganga. Peradeniya is now the headquarters of the Department of Agriculture for Ceylon. There is at present no Scientific Department in Ceylon which devotes its energies entirely to the study of tea.

At Gang-oruwa on the other side of the river from the Botanic Gardens is the experimental station. This consists of a total area of 547 acres of which 335 acres are occupied by jungle and buildings and the remainder, 212 acres, is under a diversity of crops. Thus 59 acres are under rubber, about 40 acres under cacao, 27 acres under cocoanuts, about 10 acres under coffee and 12 acres under fodder. There are smaller areas of many other crops.

To tea 21½ acres are devoted. On one block the lasting efficiency of cattle manure is demonstrated and thirteen years after application the effects are still evident. A series of manurial trials is being carried out on long, one acre blocks. Nitrogen, potash and phosphate dressings in various combinations are given annually. The results show that nitrogen always gets a response and, so far as can be seen, potash shows little effect. The soil at Gang-oruwa is a red one and the results obtained above correspond with observations made on the heavier Assam red soils. The efficiency of green manuring is also shown.

The cover crop plots are very fine and include all the crops used in North East India. Cowpeas (*Vigna catiang*) which is perhaps our best green crop is not a success in Ceylon where it is liable to attack by the Kaluchura snail.

One important point which has been pressed home by the scientists of Peradeniya is the superior efficacy of good cultivation and manuring over plant sanitation as a means of pest and blight control. A healthy plant resulting from good cultivation and manuring is the best guard against blight attack and this view has been accepted by tea planters in Ceylon much more readily than in Assam.

Ceylon Tea Soils.

The Ceylon rocks excepting those in the north and those round the coast belong to the Archaen period in Geology and are related to the Charnockite gneisses and granites of southern India. Round the coast of Ceylon where most of the coconut plantations are situated the soil is sandy. Towards the interior it gets heavier and the amount of "kabuk" or laterite increases. The best and some of the heaviest soils are found near Nuwara Eliya.

The tea land is divided into forest, *patana* and *chena* areas. The *patanas* are grassy downs common in the Uva province. *Chena* is land which has been burnt by the natives before cultivation. This type of land resembles the *jhoomed* areas of Assam and is not planted up if other land can be obtained. The forest areas are of course the best but now that these lands are no longer available, extensions are being made on the *patanas* where the soil is poorer and less deep.

Practically all the tea soils have been formed *in situ* from the rocks beneath them and in this way they resemble the Darjeeling soils. Most of the soils are red although in places quartz patches appear forming light coloured soils. Owing to the tremendous amount of wash on the hill slopes the soil remaining on most estates is not representative of the true type which will only be found in the jungle.

A comparison with North East India tea soils is interesting. In our own areas we have, broadly speaking, two types of soil, old and new, red and greyish. The new soils have been put down by the Brahmaputra and its tributaries. These soils vary in texture according to the slope of the land and the distance from the river course. The old soils are usually the remains of the previous floor of the Assam Valley before the most recent wash out by the Brahmaputra. The Darjeeling soils are formed by the weathering of the granites and gneisses of the Himalayas and are perhaps the oldest tea soils in North East India although they are modern compared with the Ceylon tea soils.

Now these older soils, which during weathering have turned red, do not as a rule show a regular gradation in their mechanical composition. Thus often it is found that the major fractions are sand and clay which could not occur if the soil were put down by sedimentation. Such soils are formed *in situ* or are sedimentary soils which have changed during a long period of weathering.

Below are shown the mechanical analyses of some Ceylon forest soils taken in the tea districts* together with some North East India tea soils. The percentages of the finer fractions have been re-calculated, omitting the fine gravel in order that the values may be compared with those of North East India where gravel is so rare that it is not included in our analyses.

CEYLON FOREST SOILS.

	Sabaragamuwa.		Central Provinces.		Uva.	
	Permadulla.	Rutnapura.	Kandy.	Nuwara Eliya.	Paliyagoda.	Galhada.
	%	%	%	%	%	%
Coarse Gravel	44	19	6	5	1	13
Fine ,, ...	38	27	31	29	10	24
Coarse sand	34	39	39	20	34	30
Fine sand	16	29	22	19	33	30
Silt	13	15	10	13	8	10
Fine silt	17	14	22	23	15	14
Clay	20	9	8	25	10	15

NORTH EAST INDIA TEA SOILS.

	Assam sand.	Dooars sand.	Assam yellow clay.	Dooars Red Bank.	Sylhet teelah.	Darjeeling.
	%	%	%	%	%	%
Coarse sand	29	76	nil	20	30	25
Fine ,, ...	32	14	16	16	24	5
Silt	16	2	24	14	15	16
Fine silt	12	5	28	15	7	11
Clay	7	1	25	26	18	24

The Ceylon soils do not exhibit so clearly as the North East India soils the characteristics of an old soil. The Permadulla,

*Bruce—Forest Soils of Ceylon.

Nuwara Eliya and Galhada samples show the increase in clay content although not to the same extent as do the soils from the Dooars Red Bank, the Sylhet teelah and Darjeeling. The Ratnapura and Kandy soils resemble the Mal sands of the Dooars.

The absence of gravel in most of the North East Indian soils is noteworthy. There are rarely any stones in Assam except in parts of Darrang. Gravel sometimes occurs on the Sylhet teelahs, and the Dooars gardens, which are frequently put out on old river beds, are often full of stones.

A comparison of the chemical properties of soils from the two countries is of interest. Unfortunately no recent chemical analyses of the actual tea soils of Ceylon are available. The analyses below correspond to the mechanical analyses given above and were made on forest soils.

CEYLON FOREST SOILS.

	Sabaragamuwa.		Central Province.		Uva.	
	Permadulla.	Ratnapura.	Kandy.	Nuwara Eliya.	Paliyagoda.	Galhada.
	%	%	%	%	%	%
Loss on ignition ...	15·2	16·8	9·1	21·4	5·5	5·5
Oxides of iron and alumina	26·8	34·3	23·7	30·2	15·4	19·6
Sand and silicates ...	51·1	53·9	60·8	41·3	75·3	69·1
Lime	0·28	0·20	0·38	0·22	0·18	0·20
Nitrogen	0·252	0·207	0·140	0·431	0·112	0·140
Available potash ...	0·018	0·007	0·019	0·014	0·034	0·016
Av. phosphoric acid ...	0·0006	0·094	0·006	0·010	0·003	0·005
Acidity (p H) ...	6·9	7·1	6·7	6·4	7·2	7·4

The high percentage of iron and alumina is evidence of the extreme age of the soils. The loss on ignition which is made up largely of combined water cannot be taken as a measure of the organic matter as is the case with the newer soils in Assam.

The insoluble sand and silicates are often lower than 50 per cent. in Ceylon soils. This figure is seldom reached, except in peat soils, with North East India soils, in fact with Assam sandy soils the value is nearer 90 per cent. The heavier soils

of the Dooars Red Bank frequently show a value of about 70 per cent. Although the insoluble silicates come partly from the clay fraction, still in Assam soils the quartz percentage is high, and even very heavy clays do not show insoluble silicates like the Ceylon soils. The following values are representative for North East India.

NORTH EAST INDIA TEA SOILS.

	Assam sand.	Dooars sand.	Assam yellow clay.	Dooars Red Bank.	Sylhet teelah.	Darjeeling.
	%	%	%	%	%	%
Loss on ignition ...	2·87	3·55	6·52	11·60	10·15	8·78
Oxides of iron and alumina	3·04	6·33	8·66	17·88	9·53	11·44
Sand and silicates ...	93·70	88·42	77·86	68·62	74·40	78·07
Lime	0·04	0·10	0·10	0·15	0·09	0·10
Nitrogen	0·09	0·11	0·148	0·27	0·21	0·24
Av. Potash	0·013	0·040	0·017	0·012	0·010	0·011
Av. phosphoric acid ...	0·001	0·038	0·023	0·019	0·005	0·012

The fertile tea soils of North East India are all acid, and alkaline soils fail to grow tea. The Assam tea soils usually shows pH values of the order 5 to 6 whilst the pH values of Ceylon tea soils given by Bruce, vary within a close range of 7, *i.e.*, neutrality, and the majority are just alkaline.

Below is shown some analyses of Ceylon tea soils made about twenty-five years ago.* In many respects they compare with the forest soils shown in a previous table. The Haputale sample is described as a typical *patana* soil.

CEYLON TEA SOILS.

	Subaragamuwa.		Central Province.		Uva.	
	Kalucheura.	Kelani valley.	Matale.	Nuwara Eliya.	Badulla.	Haputale.
	%	%	%	%	%	%
Loss on ignition ...	8·16	11·86	12·39	13·30	8·18	6·06
Oxides of iron and alumina	21·85	22·00	19·25	21·92	20·41	23·31
Sand and silicates ...	69·02	65·74	56·49	63·82	71·12	70·24
Lime	0·43	0·103	0·046	0·266	0·20	0·043
Nitrogen	0·182	0·159	0·137	0·406	0·086	0·136

*Bamber—Ceylon Tea Soils.

Except in the Bogawantalawa district there is nothing in Ceylon to compare with the peat soils of Cachar. A sample of soil from Bogawantalawa containing 0.799 per cent. nitrogen gave a crop of 2,225 lbs. per acre which compares well with a crop of 2,400 lbs. (30 maunds) obtained in Cachar.

The average Ceylon tea soil contains essential plant food as follows :—

Nitrogen	... 0.10 to 0.15 %
Available potash ...	... 0.010 to 0.015 %
,, phosphate ...	... 0.005 %

The figures compare very well with the average of North East India tea soils although a close comparison between soils of such different origin is of little use.

Planting, Pruning and Plucking.

The importation of Indian tea seeds into Ceylon is forbidden on account of the risk of Blister blight (*Exobasium vexans*). It is said that the spores of the blight may be carried within the seed in which case disinfection would be useless.* Planters have urged the waiving of the retriction but without success. The result is that tea seed is grown locally in increasing quantities although the price is still much higher in Ceylon than in India.

Seeds are usually germinated and put out in shaded nurseries. Both dark and light leaved Assam indigenous, China and China hybrid bushes are common. The usual bush is a medium hybrid which stands the climate better than other *jats*.

The plants are transplanted at about 18 months sometimes with a clod but generally as a stump. The young plant is cut in the nursery at a height varying from 4 to 8 inches and the soil is then loosened and the plant pulled up. In some cases trouble is not even taken to loosen the soil and the seedling is pulled up and

*The Trop. Agriculturist, Vol. LXI, No. 5. The Importation of Tea Seed from India.

sent, perhaps long distances, to other estates for planting. The price of stumps varies from Rs. 15 to Rs. 40 per thousand.

Although in Assam stump planting is never employed carrot planting is not uncommon. By this means the whole plant, uncut and without a clod, is transplanted. At Tocklai experiments have been carried out to find the difference between clod and carrot planting and in every case clod planting has given by far the better results. It is true that conditions are more difficult in Assam where we often have to transplant with a long drought before us.

In order to transfer tea stumps from one district to another government permits are necessary. It is not permitted to carry stumps out of an area where the pest, tortrix, is bad.

The planting season varies with the district. In the south-west monsoon area the season is June, July and August. In the Uva Province where the north-east monsoon is the wettest period, the planting season is during this monsoon—November, December and January.

The planting in Ceylon is of the order three feet by three-and-a-half, much closer than in Assam on the flat, but resembling that employed on the Sylhet *teelahs*. In spite of the fact that all the tea is on the hill slopes contour planting has not been generally adopted.

The wood in Ceylon is usually greatly inferior to that in North East India although on some estates bushes equal to anything in our best gardens are seen. The pruning and plucking methods of Ceylon do not tend to make such fine bushes as do the methods of Assam.

The root development judged from the appearance of exposed roots is very good and this is often the case in Assam where tea is planted on slopes liable to wash. The exposed roots often develop branches which are usually cut off.

Ceylon pruning methods differ essentially from those of North East India where broadly speaking a bush is made by one of two methods. The young plant when its stem is about 1¼

inches in diameter near the ground is cut an inch or two above the collar. The next cut may be down at about a foot in a year or so, perhaps after several years. As an alternative to such drastic treatment the bush may be built up by the judicious removal of centre branches which will induce the plant to throw out branches from low down and so form a good frame without the loss in crop, early on, which follows a low prune.

In Ceylon where the plucking is continuous throughout the year, bushes are never pruned annually. In the low country pruning is done about every 18 months, in the medium country once in two or three years and in the high country once in three or four years.

Pruning time must be regulated so as to avoid the drought and the winds during the south-west monsoon. On the south-west side pruning is carried on from mid June to mid September but in parts where the rainfall is continuous, pruning may be carried on all the year round. In the Uva district pruning is done in November. A young plant unless it is cut in the nursery to about 4 inches is unable to withstand the wind pressure during the monsoon.

The first cut is made after the bush has been transplanted about two years although this period varies according to altitude. This is a cut across at about eight inches from the ground. The bush is then tipped at about twelve inches. The next pruning is made on two or three inches of new wood on top of the first eight inches and the bush is tipped a few inches above this. The ordinary pruning is a cut made about two inches above the old cut although when the wood becomes knotty the cut is made lower down on straight wood. In some districts it is common to prune up three times and then to come down. There are naturally many variations of these methods both in detail and in time.

Old tea is seldom collar pruned although in the Matale district this treatment has proved very successful. Very low pruning is a common practice. "Skiffing" or cutting the bush across the top at a height of about three feet, is not practised in Ceylon.

In the low country a bush may be brought into full bearing after about five years and in the high country after six or seven years.

After pruning, the bush is out of commission for a period varying according to the altitude. In the low country the bush is tipped from six to eight weeks after pruning and the first flush comes after about eleven weeks from pruning. In the mid-country it is usual to tip about three months after pruning or with weaker bushes where more growth is left this period may be as long as four to five months. In the high country these periods are longer.

In Assam we pluck longer and coarser but generally closer than in Ceylon. It is not usual to pluck below 27 inches and in districts where slightly lower plucking is employed, three, two and one leaf are left on successive flushes and plucking to the *janum* or "fish leaf" is not employed till about August. In some districts of Assam it is usual to pluck to the *janum* from the beginning of the season. On medium pruned tea at least nine inches growth is left before plucking and on light pruned tea it is usual to leave six inches. In Ceylon plucking starts at about twelve inches from the ground and each time one leaf is left above the *janum* so that the bush gradually gets higher and after three years' plucking it may have crept up three or four feet on the tipping. It is often necessary to prune a bush because it is too high to pluck.

The plucking in Ceylon is much finer than in India and each plucking woman picks over her leaf under supervision before it goes to the withering racks. A seven-day pluck is aimed at although during the second and third year after pruning this period may lengthen out to eight and more days.

The yield naturally varies according to pruning time. Thus on one of the high grown estates the following values were given :—

First year after pruning	...	500 lbs.
Second ,, ,, ,,	...	900 ,,
Third ,, ,, ,,	...	950 ,,
Fourth ,, ,, ,,	...	850 ,,

A bush generally shows a need for pruning by going *banjhi*. It is customary for the last two or three rounds before pruning to pluck harder than usual.

Manuring and Cultivation.

The manuring of tea is a much older practice in Ceylon than in Assam. The reason for this is probably that tea was first put out on old coffee land which was partially exhausted. In Assam the first manuring consisted in top dressing the soil from the *hullahs* and *bheels*.

In Ceylon there have been few carefully carried out manuring experiments and most manure mixtures are devised by visiting agents who work chiefly on their own experience. The result is that there is a tendency to manure in groups of estates rather than on types of soil.

Manuring is sometimes done biennially although the benefit of annual applications has been demonstrated. The pruning mixture is added in February or March or a month before pruning. The other mixture is added about 8 months after pruning. In general, manuring may be carried out at all times except during the drought or the monsoon. A common time for application is with the first rains.

Cattle manure is seldom used. Liming is not popular but a small quantity, 500 lbs., may be buried with the prunings although for this purpose basic slag is preferred. It is considered that the nature of the soil acidity in Ceylon does not call for lime so far as tea is concerned.

Some typical pruning mixtures are made up as follows. Burnt lime, nitrolim, basic slag and nitrate of potash at the rate of 350 lbs. per acre. This mixture is arranged to give about 14 lbs. nitrogen, 8 lbs. phosphoric acid and 17 lbs. potash. Another is made up of—

ground-nut cake
fish guano
blood meal
steamed bone meal
nitrate of potash

} at the rate of 700 lbs. per acre.

containing about 53 lbs. nitrogen, 25 lbs. phosphoric acid, 20 lbs. potash.

Other mixtures for ordinary use are still more complicated. For example, one gives—

ground-nut cake fish guano concentrated super nitrate of potash muriate of potash milled fish sulphate of ammonia	at the rate of 500 lbs. per acre.

Another gives—

ground-nut cake fish guano blood meal nitrolim steamed bone meal mineral phosphate nitrate of potash sulphate of potash	at the rate of 750 lbs. per acre.

Although many of the mixtures are uneconomical and some unscientific yet they mostly combine slow and quick acting manures which give good results. These mixtures offer a distinct contrast to the simple two or three component mixtures used in Assam.

A pruning mixture may be made up to supply the three constituents as follows—

Nitrogen/Phosphoric acid/Potash = 14/35/16 lbs. per acre and an ordinary mixture may be made up to contain—

Nitrogen/Phosphoric acid/Potash = 42/16/32 lbs. per acre. Pruning mixtures are usually rich in phosphates.

Green manuring in the manner that it is carried on in Assam is not employed in Ceylon. The quick crop like cowpeas (*Vigna catiang*), sunn hemp (*Crotalaria jancia*) or dhaincha

(*Sesbannia aculcata*) which can be grown and hoed in in six weeks is not used.

As shade and a source of green manure, dadap (*Erythrina lithosperma*) is the most popular tree below 4,000 feet. It grows best at about 1,600 feet and is generally planted about twenty feet square and lopped at twelve feet. The lopping is done three or four times a year, once with deep cultivation when the loppings are buried. At other times the loppings are left as a mulch. At Peradeniya it has been found that the weight of the loppings average about 10,000 lbs. per acre with two loppings a year, 20,000 lbs. with three loppings and 23,000 lbs. with four loppings in a year.

Trials with Gliricidia maculata have shown that this tree gives almost double the loppings of dadap. It grows well up to about 2,500 feet. Albizia molucanna, the Ceylon Sau, is grown as shade up to 4,000 feet and although it can be lopped is not commonly used in that way.

In the higher gardens above 4,000 feet the wattle (*Acacia decurrens*) is used for shade and lopping and the silver oak (*Grevilla robusta*) as shade and as a wind belt. The latter are not lopped. Blue gum (*Eucalyptus globulus*) is also used as a wind belt.

A visitor from the Assam tea districts is struck by the freedom from weeds of the Ceylon tea estates. The soil is usually quite clean and any isolated weeds which appear are scraped up and burnt or collected and buried. The result is that soil erosion in Ceylon presents a serious problem. On this account manuring must be heavy to make up for the plant food lost by wash.

Arguments put forward in favour of clean weeding include the fact that it is cheaper to keep the estate absolutely clean than to weed periodically. It must be remembered that in Ceylon there is no period of drought as there is in North East India when weeds cease to grow or do so at a very slow rate. Another point is that with weeds come leeches which are so serious in some districts that coolies are unable to go in to pluck the bushes.

Apart from the loss of organic matter which clean weeding entails and the soil wash, a clean soil is undoubtedly a great advantage to the tea bush and this no doubt accounts to a great extent for the big crops obtained in Ceylon.

On the hill slopes in Japan, soil wash is avoided by hedge planting the tea bushes. In Ceylon, Boga medeloa is sometimes planted in hedges to obviate soil wash but this is not common. In some estates contour stone walls are built and contour drains and silt pits are dug but compared with the contour work done in the Surma Valley and Darjeeling this is negligible.

Cultivation or deep forking which is done with an English fork may be put in at any time of the year but generally with the manures. The deeper the cultivation the less is the subsequent soil wash.

Pests and Blights.

Most of the pests and blights common in North East India are found in Ceylon. The tortrix and shot hole borer are the ones which cause most loss of crop. The shot hole borer is, as yet, unknown in North East India and the tortrix although common is not a serious pest.

The tortrix grub lives in the lower leaves of the bushes and at the third or fourth cast moves to the flush which is then enclosed in a web and ceases to be of any use as leaf. The tortrix may be controlled by collecting the eggs but a more efficient method of control is the establishment of flight breaks. The moth has only a short flight range and since it is carried by the south-west monsoon it is suggested that a system of breaks would fairly well limit the area affected by the moth. The control of this blight calls for co-operative treatment.

The shot hole borer as its name denotes bores holes in the branches and renders them useless as leaf bearers. It has been found that good cultivation and nitrogenous manuring decrease the effect of this pest.

The Kaluchura snail is a pest in the low country. Red spider is common in the higher levels especially during a

drought. White ants are common in the Central Province where the attacked bush is dug out or if it is not completely eaten away it is treated with creosote or solignum. The Tea Mosquito occurs sometimes in the low country. It is often confused with Circa Sporella, a leaf disease, the mark of which resembles that left by the mosquito, and unless the mosquito itself is seen its presence is doubted.

Leaf and stem diseases occur much as in Assam. Of the root diseases, Urstulina is the commonest and Diplodia the most serious.

In Ceylon the systematic spraying of tea estates is not carried out as is the practice in many gardens in India.

THE MANUFACTURING PROCESS.

In many ways tea manufacture in Ceylon differs from that in Assam. The older Ceylon factories are usually built in the valleys in order to get water power. The newer ones are often of brick or stone, built on sites calculated to get the breeze for withering purposes. There is generally less machinery than in Indian factories because the same crop does not involve the same rush as in India.

Withering.—Outside withering houses are not used in Ceylon and all the withering space is above the factory so that the wither can be controlled.

As soon as the leaf has been picked over and weighed it is spread on the "tats" or racks. The racks are of hessian, fixed on the slope about six inches apart. The spreading is much thinner than in India for whereas we spread one pound of leaf on about nine square feet, in Ceylon, twelve or more square feet are employed.

If 100 lbs. fresh leaf dry to 55 lbs., this is called a 55 per cent. wither. This is a normal wither and the leaf contains about 54 per cent. moisture. Now in Assam leaf containing 60 to 65 per cent. moisture is considered well withered. The lower figure represents a 64 per cent. wither by the Ceylon

method of reckoning and would be considered an under wither or a soft wither. A 60 per cent. wither corresponding to 58 per cent. moisture is a light wither. A 50 per cent. wither corresponding to 50 per cent. moisture is a hard wither.

In many factories the leaf is weighed after withering and from this weight and the fresh leaf weight the exact degree of the wither is calculated.

It is considered* that a soft wither or under wither gives soft but thick liquors and that a hard wither gives pungent teas but pale liquors. An over wither gives light thin liquors. This is contrary to experience in Assam where we explain the withering process as follows. During withering the tannin content of the leaf does not change but it is believed that the state of part, at any rate, of the tannin complex changes. In an under-withered leaf which is not ready chemically, this change has not proceeded far and the tea has a bitter or "raw" taste. During withering "rawness" gives place to pungency.

In Ceylon the wither is controlled. In the factory the firing room occupies a central position and above this is a hot air chamber running right across the withering loft and extending through each floor to the roof. The hot air from the drying room is taken into this chamber where it is bulked and then, by means of sliding doors it is passed into whichever loft it is required. The air is drawn through the loft by means of fans.

Now whilst it is realised that a natural wither is preferable to an artificial one since it is generally carried out at a lower temperature, it is often impossible to get a natural wither especially in the more elevated areas. On this account all the withering lofts whilst plentifully supplied with windows in case of fine weather, are capable of being shut up and made airtight in humid weather.

Much work has been carried out in connection with artificial withering and many valuable results have been obtained.† In

*H. J. Moppett—Tea Manufacture, its Theory and Practice in Ceylon, p. 18.

†F. J. Whitehead—Notes on the Artificial Withering of Tea Leaf.

an artificial wither although the temperature is important, the controlling factor is the relative humidity or drying power of the air.

It has been found that if the length through which the air is drawn is 100 feet, and the air is changed once in two minutes, and the difference between the wet and dry bulbs of the hygrometer where the hot air enters the loft is 6—8°F, then a satisfactory wither can be obtained in about 24 hours.

It will be realised that as the air passes over the withering leaf it picks up moisture and loses its drying capacity. Now if the loft is longer than 100 feet, then, for efficiency, the rate of the air flow must be so increased that the drying of the leaf on the first few ranges of drying racks will be so great that the leaf will be spoilt.

If the difference between the wet and dry bulb thermometers in the outside atmosphere is about 7° then there is no need for artificially drying the air.

Experience in Ceylon shows that if the wither is controlled, then the hot air should be used during the early stages of the wither in order that good results should be obtained.

In Assam it is generally possible to wither during at least twelve hours of the day during the monsoon but in the Dooars this is often not so and many factories have withering lofts. Withering, as has already been stated, is governed chiefly by the relative humidity of the atmosphere but the temperature is also a factor and it is probable that because in North East India the temperature of the loft is perhaps 100°F against 80°F in the more elevated estates of Ceylon, a higher humidity, *i.e.*, a smaller difference between the wet and dry bulbs would suffice to wither our leaf.

Rolling.—In Ceylon it is common to roll as many as eight times and never less than three. Five rolls may be taken as the average. Between each roll the leaf is put through a sorter or roll-breaker and the fine bulk is put aside for fermentation.

A common type of roll is as follows :—

30 minutes with no pressure
30 ,, ,, slight pressure
30 ,, ,, half ,,
30 ,, ,, full ,,

The sorting which is done on a tray machine takes about 10 minutes, and during the successive sortings the leaf for further rolling dwindles down to half the original or even less.

The Assam practice is on the average as follows. The first two rolls total about an hour with sorting between. The first roll is usually lighter and shorter than the second. In the sorting, from 25 per cent. to 40 per cent. of the leaf is removed. This percentage depends of course on the fineness of the plucking and the degree of wither. An under-wither gives much more broken leaf and a greater percentage of fine bulk or fine *mal*. The actual bud and first leaf which should comprise the fine *mal* is about 35 per cent. of the shoot. It is common to give a final 10-minute roll before firing for the sake of appearance.

One important difference between Ceylon and Indian rolling is the number of revolutions made per minute. In Ceylon this value is rarely above 45 whilst in Assam the general figure is 60 and tea is often rolled at 70 or more revolutions. This difference in speed of rolling makes a comparison between the methods difficult for the faster roll has a greater mechanical effect than the slower one.

In Ceylon the type of roll depends on the elevation, the type of wither, the season and the kind of tea which is required. In Uva during the flavour season, the number of rolls is reduced to three.

A careful study of conditions by Moppett * has led to the following suggestions with regard to rolling.

*H. J. Moppett—loc. cit.

For appearance, the leaf should be just over medium withered and the rolling should be as follows :—

25 minutes with no pressure
25 ,, ,, ,, ,,
30 ,, ,, 15 minutes light pressure
15 ,, half ,,
45 ,, ,, full pressure—10 minutes on
— 5 ,, off.

A suggestion for making broken grades on gardens at altitudes of about 3,500 feet is as follows :—

30 minutes with no pressure
30 ,, ,, ,, ,,
30 ,, ,, half ,,
20 ,, ,, fairly hard pressure
20 ,, ,, pressure as hard as possible and 3 minutes break at half time.
20 ,, ,, pressure as hard as possible and 3 minutes break at half time.

At higher altitudes the rolling may be extended but it should be reduced at lower altitudes.

In the low country the following programme may be followed.

40 minutes with no pressure
40 ,, ,, medium pressure—7 minutes on
—3 ,, off.
40 ,, ,, hard pressure—10 minutes on
— 5 ,, off.

With over withered leaf, water is added to the roller and after a light roll the following ones are heavy.

A heavy first roll produces flat leaf with little tip. Extra hard rolling gives broken grades which require little sorting afterwards but this method is not to be advised. A hard roll on under withered leaf gives flaky teas.

In Ceylon a triple action roller with a revolving pressure cap fitted with battens is sometimes used. Wooden battens are

considered better than brass ones and deep battens are best for making broken grades.

Expressors are seldom used and the opinion is that they detract from the quality of the tea.

Fermentation.—The ideas on fermentation differ widely in Ceylon and India. In Ceylon the tea is spread thinly on glass or cement tables with little attempt to control the air supply. In fact the idea is that plenty of cool, moist air should flow over the fermenting leaf. In Assam our fermenting rooms are walled off and air is only admitted through holes about 3 feet up the walls. A direct air flow is kept off the leaf and to ensure this, damp cloth is often placed on top of the fermenting leaf and the packing is made as thick as possible (at times up to five inches) provided that the temperature does not rise above 86°F.

Fermentation in Assam if carried out on the same lines as in Ceylon would give dull, flat teas. It must be remembered, however, that we often work above 85°F whereas in Ceylon the temperature is in many places as low as 60°F. There is thus often a difference of almost 18°F between working temperatures and on this account any chemical action taking place in the fermenting leaf will proceed twice as fast in Assam as in Ceylon.

In Ceylon the leaf is spread from a half to two inches thick, one and a half inches being the average. The fine bulk is fermented about two and a half hours and the coarse about three and a half hours and the final rolls are put straight into the dryer without any fermentation.

As in North East India, drying of the fermenting leaf is feared in Ceylon and so long as moist air flows over the ferment no harm is thought to be done. Most fermenting houses are furnished with hessian curtains which are kept damp and in some factories damp hessian is kept above, but not on the fermenting leaf itself.

As in India it has been noticed that a short fermentation makes for pungency. For flavour a three-hour limit is set on fermentation, after which time liquors are made at the expense of the other properties.

Firing.—The larger drying machines in use in Assam are seldom employed in Ceylon. The large Paragon dryer, the Down Draft Sirocco and the Double Tilter are in common use. The favourite machines are the Colombo Dryer and Brown's Dessicator, both made by Colombo firms.

The Colombo Dryer is a six-tray up draft with an out-put of 120-150 lbs. an hour. Brown's Dessicator only turns out from 80 to 100 lbs. an hour but it is in many respects ideal. It consists of a long box through which two rows of tray can be pushed. There are generally four trays in each row and the baffles are so arranged that the hot, dry air at 200°F can be brought straight on to the fresh leaf if necessary or on the partially dried leaf.

From the theoretical point of view the first work of the dryer should be to stop the fermentation process by killing the yeasts and by rendering the enzymes inactive and this is only achieved satisfactory if the incoming leaf is met by a blast of air having a temperature not lower than 120 F.

In Ceylon the tea is dried in one process although in the earlier days double firing was practised. In Assam we double fire, and the first process, which is generally carried out in one of the larger machine, dries the leaf to 12 or 14 annas, *i.e.*, 3/4 or 7/8 of a full fire, and the tea is then fully dried on a smaller machine. It has been found inconvenient to fire once only, partly owing to the difficulty in hitting the right mark and partly because of the loss in efficiency by so working. Withering as we do to about 65 per cent. moisture compared with about 54 per cent. in Ceylon there is about an extra 11 per cent. mositure to remove which roughly equals the 2 annas (*i.e.*, 1/8 or 12½ per cent.) removed in the second fire.

The firing temperatures are from 10°F to 20°F lower in Ceylon than Assam.

Sour leaf is best high fired. Sun firing is sometimes employed in Ceylon giving a pungent tea with a somewhat

metallic or brassy flavour. Sun fired tea is not sufficiently dry for export.

Tea is usually refired before boxing during the monsoon. Dried tea is reckoned to contain about 3 per cent. moisture and it is supposed that it will pick up about another 2 per cent. during sifting. In Assam we aim at 6 per cent. moisture in our boxed teas.

There is much discussion in the tea districts about the cold drying of tea. It is considered, and rightly so, that the aroma which is always present round a tea factory represents so much loss and in order to obviate this, many attempts have been made to cold dry the tea.

Artificially dried air at a temperature of about 65°F is passed over the leaf and the result is a good flavoured tea but one which will not keep unless it is also hot dried to a certain extent. It is doubtful whether drying alone will stop fermentation sufficiently for the action of a dryer in this direction includes heating, drying and oxidation.

Sifting and Grading.—In Ceylon the tea is not sumbitted to so much breaking and sifting as it gets in India. This must in part, at any rate, account for the blackness of Ceylon teas as compared with those of India. Practically all the sorting is done on machines of the tray type.

Ceylon Teas.

Ceylon teas have distinctive characteristics and a flavour quite different from that of Indian teas. The low-grown teas are generally liquoring teas with good, black leaf, well rolled and well made. The mid-country teas are not so well made and are often flaky and give poor liquors. The high country teas are noted for their flavour although the liquors are light. Assam teas show liquors and a pungency not met in Ceylon.

Owing to more careful withering, longer rolling and less sorting, the Ceylon teas are better made, and blacker than the Assam teas which are often flat in appearance and grey.

It has for some years past been the object of chemists studying tea to correlate the results of their analyses with the market value of the tea. So far most of the work has been connected with tea tannin and the modifications it undergoes during manufacture. Although no relationship between the price of the tea and the tannin content of the leaf has been established the tannin content of tea during the various stages of manufacture is of interest. The table below shows the loss in tannin during manufacture.

	Ceylon Tea(†).	Indian Tea(‡).	Japan Green Tea(‡).
Fresh leaf	22.33%	22·20%	15·20%
Withered leaf	22·13%	22·20%	.....
Rolled leaf	20·75%	.....	.....
Fermented leaf	13·24%	12·88%	.....
Finished tea	12·92%	11·99%	12·18%

The close agreement between Ceylon and Indian teas is remarkable. The Japanese tea is of interest chiefly for the low tannin content of the fresh leaf. In Japan all the bushes are of the China type and it is interesting to note that China bushes grown in Assam have a tannin content of about 22 per cent., the same as the Assam indigenous bushes.

The average tannin content of many Ceylon teas is 11.01 per cent. varying between 7.17 and 13.02 per cent. Much greater variation has been observed in Indian teas which on the whole are usually richer in tannin than Ceylon teas.

Below are given some values recently obtained of the tannin content of finished teas from Ceylon, South India and Assam.

Ceylon Teas.		Assam Teas.		S. Indian Teas.	
Maha Uva—B. O. P.	11·71%	Assam—B. O. P.	12·47%	B. O. P.	9·20%
,, ,, —Pekoe	8·36%	Halmirah—P. F.	11·12%	B. P.	9·33%
alt. 4,200 ft.					
Rondura—B. O. P.	9·06%	Amguri—B. P. S.	12·53%	B. P. S.	9·05%
,, —P. S.	7·56%	Assam ...	12·30%	Fannings	9·36%
alt. 1,800 to 2,000 ft.					
Demodera—B. O. P.	6·54%	Doiang—B. P. S.	11·53%		
,, - Pekoe	6·12%	Seconee—B. P. S.	11·53%		
alt. 3,500 ft.					

†M. Kelway Bamber—Ceylon Tea Soils, 1900.
‡Harler—Tea in Japan, I. T. A., Q. J., Pt. I, 1924.

Apart from the price of the tea it might be expected that the pungency of a tea would vary with the tannin content, but this is not so. The Demodera sample is described by the tasters as "fine, pungent" whilst the Halmirah tea is described as "pungent" and the Seconee sample as "non-pungent."

It will be many years before the chemical and biological changes going on during tea manufacture have been elucidated and in the meantime the tea taster is the actual analyst who decides the value of a tea. Many tea tasters have studied the problem in tea factories and, by tasting, have greatly improved manufacture. Although scientific tea manufacture will finally be worked out in the laboratory, in the meantime the best results and the quickest advancement will be made by the chemist and the taster working together in the tea factory.

PHOSPHORIC ACID AND POTASH.

BY

H. R. COOPER.

Phosphoric acid and potash with nitrogen complete the trio of substances which have to be added to the soil as plant-food. Of the three, and for tea in particular, nitrogen is of the greatest importance, but the other two cannot be neglected. If nitrogen is used alone, increased crop can nearly always be obtained. The crop removed, however, contains not only nitrogen but also phosphoric acid and potash, and the bigger the crop the more rapidly are the reserves of available phosphoric acid and potash in the soil depleted. Exhaustion of one or both must follow, with serious results except in cases where the soil naturally contains an ample supply.

A crop of 10 maunds of tea removes about—

40 lbs. nitrogen
8 lbs. phosphoric acid
20 lbs. potash.

In addition to the plant food thus removed from the soil, losses also occur by washing out.

The amount thus lost varies considerably, being greatest in sandy and well cultivated soils, and least in heavy soils which are well covered with bushes and jungle.

The loss of nitrogen by washing out is always very considerable. In a case at Pusa where the drainage water from a drain gauge was analysed, the loss in nitrogen in one year of 75-inch rainfall, was found to be 200 lbs. per acre from fallow soil, and 50 lbs. from soil occupied by a maize crop. Losses by washing out from well cultivated light tea soils probably exceed 50 lbs. of nitrogen per annum.

Losses of potash are very much less but still appreciable, while the loss of phosphoric acid is smaller still.

As would be expected from these figures it is the nitrogen content of the soil which most commonly needs replenishment. Of the other two, although potash is lost more rapidly than phosphoric acid, yet phosphoric acid is more commonly needed by tea soils than potash.

The amount of phosphoric acid in tea soils is generally between .03 per cent. and .20 per cent., and when the amount approaches the lower figure, particularly in a heavy soil, an insufficient quantity of it is available for use by the plant.

On the other hand the amount of potash in a tea soil usually lies between 0.15 per cent. (say *6,000 lbs. in the top foot of soil per acre) and 1.00 per cent., and it is, generally, only when a quantity approaching the lower figure is found in a sandy soil that potash manuring gives much direct increase of crop.

Phosphoric Acid.

The special functions of phosphoric acid in a soil are to hasten maturity, to induce a healthy degree of wooding up of sappy green shoots, and to induce flowering. It is hence more valuable to heavy soils, particularly in wet situations, which tend to be late; while excess on light, early soils may do harm by inducing too early wooding up of shoots and in extreme cases may cause greater loss of crop by producing flowers, particularly with China and hybrid bushes. It may in many cases, assist the decomposition of nitrogenous manures so that the soil makes better use of the expensive nitrogen. There is a distinct tendency to the production of better quality tea by the use of phosphatic manures, particularly where the flush-producing nitrogen is also used, probably because the phosphoric acid helps to produce regular flushes, rather than rushes of quickly grown leaf of poor quality.

*This quantity would appear to be sufficient to allow large annual losses without harm, but the greater part of it is present in insoluble forms useless for plant food. It is the more soluble and valuable part which suffers loss, and is only very slowly replaced by decomposition of the insoluble potash compounds.

Sufficient phosphoric acid is also necessary to produce good root growth.

Except on sandy soils already rich in phosphoric acid it is usually found better to manure tea with a mixture containing both phosphoric acid and nitrogen, than to use nitrogen alone. Phosphoric acid, however, only rarely gives a significant increase in the tea crop, if used alone.

Leguminous crops like cowpeas and dhaincha, however, do benefit from phosphatic manures alone. Such plants should be able to obtain their requirements of nitrogen direct from the air, through the agency of the bacteria living in the nodules on the roots. It has been observed that phosphatic manures not only induce better root growth of leguminous crops, but also stimulate production of the root nodules. Trials show that on a very large number of soils a much better green crop may be obtained if a phosphatic manure is applied just before sowing. At Borbhetta on soil newly opened from grazing land only about 1½ tons of cowpeas per acre can be grown on unmanured land, while a manure providing 40 lbs. of phosphoric acid per acre will produce about double the crop. The nitrogen in the extra 1½ tons of cowpeas is worth about Rs. 7, which sum will, roughly, pay for the phosphatic manure used; while the value of the additional organic matter turned into the soil is very great indeed. The presence of sufficient phosphoric acid in the soil also assists in the desired decomposition of this organic matter in the soil, while the presence of decomposing organic matter in the soil also renders phosphatic manures more efficient.

To apply phosphates and green crops together is therefore very generally a sound practice, and it is recommended that the major portion of the phosphoric acid which the soil requires should be added just before green crops are sown.* In that case, the phosphate will give a better green crop and still remain in the soil for the use of tea. Phosphates are not lost from the soil by washing out, but whatever is not actually removed by the crop, remains in the soil until used by plants, or until it passes into

*See Rotation of Manures, Q. J., 1924, Part III.

relatively insoluble forms which are very slowly available to plants.

Crops like cowpeas and dhaincha are usually left to grow only for about 6 weeks, and many experiments have been made at Borbhetta and elsewhere to determine the effect on such crops of different forms of manure supplying phosphoric acid. Several laboratory methods for measuring the availability of phosphates* have been in use among agricultural chemists for comparing, in particular, different samples of basic slag. These methods however do not give good results if applied indiscriminately to other phosphatic manures like bones and mineral phosphates. To measure the effect of phosphatic manures on a six-weeks' growth of a quick-growing leguminous crop is not only a convenient way of measuring the availability of the manure, but measures it in a way of direct practical value, since the manures will be most used in practice under the same conditions as the test. The results quoted below were obtained in this manner.

In trials of phosphatic manures, superphosphate which contains its phosphoric acid in a form soluble in water (and must therefore be immediately available) is taken as the standard. We can compare the efficiency of other manures with that of superphosphate, by comparing the increases in crop obtained by using the same weight of phosphoric acid in different forms. For example a trial in England on a rotation of crops extending over many years gave the following average increases in crop during the year in which the manures were applied :—**

Superphosphate	... 16	per cent. increase
Basic slag	... 14½	,, ,,
Bone meal	... 14½	,, ,,

We can, then, say that in this trial basic slag and bone meal had an immediate efficiency equal to 90.6 per cent. that of superphosphate.

*Solubility in weak acids like citric acid.

**Journ. Royal Agric. Soc., Eng., Vol. 74, p. 119.

Similarly the following results have been obtained for a six-weeks' growth of cowpeas, the relative efficiencies quoted being averages from trials on four different soils in the Jorhat District.*

Immediate efficiencies of Phosphatic manures.—

Superphosphate	100
Basic slag	99·5
Bone meal	72
Improved Ephos Phosphate ...	57
Ephos Basic Phosphate	32
Indophos	15

The last three are ground mineral phosphates.

In the above cases lime also was applied to all plots at the rate of 10 maunds per acre.

In another case at Borbhetta on virgin soil to which no lime or other manure had ever been applied the following relative increases were obtained :—**

Basic slag	100
Bone dust	84
Unsteamed bone meal, 3/32 mesh ...	78
Superphosphate	76
Steamed bone meal, 3/16 mesh ...	63

It will be noticed that in the absence of lime the superphosphate has a much lower efficiency than that of basic slag. Superphosphate is an acid manure, and cowpeas, unlike tea, do not grow well in over-acid soils. Also in soils deficient in lime some of the phosphoric acid of superphosphate passes into relatively insoluble compounds with iron and aluminium in the soil.

It is also interesting to note the varying efficiency of the different bone manures. Bone dust which is in a very fine state of division does best, while the coarsest of the three comes last

*Quarterly Journal, 1915, p. 94.

**Quarterly Journal, 1916, p. 127.

of all. With bones and with all relatively insoluble manures fineness of grinding is of the first importance. This point does not generally receive the attention it deserves, and much of the so-called bone-meal used in tea is very coarse and consequently of low efficiency.

The first trials with mineral phosphates were not very successful, and as mineral phosphates were not only less efficient but more expensive in India than bone meal they were not further tried at the time. Since 1915 however bone meal has nearly doubled in price, while there are now on the Calcutta market mineral phosphates which are of very fair efficiency and of reasonable price. It has been found, also, that these mineral phosphates are more efficient according as the soil is more acid, and the relative efficiency of the mineral phosphates used in the first trials was lowered by the addition of lime.

A further trial at Borbhetta in 1921 with a finely ground Indian phosphate on unlimed soil gave the following increases, using in each case 40 lbs. of phosphoric acid. Results quoted are averages from three plots :—*

	Cowpeas per acre. lbs.	Increase over check.	Increase per cent.	Relative efficiency.
No Manure	1,814	.....	.....	.....
Mineral Phosphate ...	3,853	2,039	113	58
Bone Meal	5,354	3,540	195	100

In this case the bone meal plots received 7 lbs. of nitrogen per acre which was not applied to the mineral phosphate plot, since it was desired to compare the effects of the two manures as sold.

To supply 40 lbs. of phosphoric acid, 182 lbs. of bone meal are necessary, costing (at the rate of Rs. 125 per ton) Rs. 10-2.

If a mineral phosphate has an efficiency of 58 per cent. that of bone meal, it should require about 69 lbs. of phosphoric acid as mineral phosphate to give the same immediate effect as 40 lbs.

*Quarterly Journal, 1922, p. 108.

phosphoric acid as bone meal. At present prices this quantity could be supplied by using 200 lbs. of ground Indian phosphate containing 34 per cent. phosphoric acid. This at the price now quoted (Rs. 75 per ton) would cost about Rs. 6-8. For growing a green crop therefore we can use a mineral phosphate more cheaply than bone meal, and have also the advantage of the very great residual effect of the larger quantity of phosphoric acid added.

Another experiment on a clay soil in Golaghat gave the following averages from three trials using 40 lbs. phosphoric acid per acre :—

	Mati kalai per acre. lbs.	Increase per acre. lbs.	Increase per cent.	Relative efficiency.
No Manure	4,600	.....	.....	.....
Superphosphate ...	5,650	1,050	23	100
Belgian Flour Phosphate ...	5,830	1,230	27½	120

In this case the soil had been cattle manured in former years and was not so deficient in phosphoric acid as the Borbhetta soil. Considering the late sowing (October), it gave quite a fair crop unmanured, but the increases still serve to measure the relative efficiency of the manures tried. On this acid soil the superphosphate is naturally inefficient compared to the mineral phosphate which in this case contains considerable free limestone. Taking into consideration the results on unlimed soil at Borbhetta it is probable that basic slag would have given an increase greater than that due to Belgian phosphate, but not a sufficiently great increase to compensate for the increased cost.—

40 lbs. of phosphoric acid in Belgian phosphate cost Rs. 5-5
40 lbs. of phosphoric acid in Basic slag would cost ,, 8-6.

The following manures include all those which are valued mainly for their content of phosphoric acid. Organic manures like animal and fish manures are valued mainly for their nitrogen content but contain also phosphoric acid. These manures are discussed in Quarterly Journal, 1924, Part III.

Relative costs of Phosphatic Manures.

Manures.	Phosphoric acid.	Price per ton.	Cost per unit of phosphoric acid. Cost per ton / phos. acid %	Rate of application per acre to supply 40 lbs. phosphoric acid.	Cost of applying 40 lbs. phosphoric acid.
	%	Rs.	Rs. As.	lbs.	Rs. As.
Superphosphate (Ordinary) ...	20	80	4 0	200	7 2
„ (Conctd.) ...	40	175	4 6	100	7 13
Basic slag	16	75	4 11	250	8 6
Prectd. bone phosphate ...	38	175	4 10	105	8 3
Radiophos	25	90	3 10	160	6 7
Belgian Flour Phosphate ...	20	52	2 10	200	4 10
Algerian „ „ ...	30	80	2 10	133	4 10
Ground Singhbhum Phosphate	34	75	2 3	118	3 15

The last four are ground mineral phosphates.

In calculating the unit cost of phosphoric acid in bone products an allowance has to be made for their nitrogen content. Nitrogen as sulphate of ammonia can be bought at Rs. 9-4 per unit. At this rate the 3½ per cent. nitrogen in steamed bone meal is worth Rs. 32-6, so that out of Rs. 125 per ton of bone meal we can consider that we pay Rs. 32-6 for the nitrogen, and Rs. 92-10 for the 22 per cent. of phosphoric acid. In that case the unit cost of the phosphoric acid is only Rs. 4-3 per unit, if wanted to make up a manure mixture. If however we desire to apply bone meal with a green crop we cannot use the phosphoric acid without the nitrogen, and therefore the cost of application given in the last column is the cost of sufficient bone manure to supply 40 lbs. of phosphoric acid without making any allowance.

Relative cost of Bone Products.

	Nitrogen.	Phosphoric acid.	Price per ton.	Cost* per unit of phosphoric acid.	Rate of application to supply 40 lbs. phosphoric acid per acre.	Cost of applying 40 lbs. phosphoric acid.
	%	%	Rs.	Rs. As.	lbs.	Rs. As.
Steamed bone meal...	3½	22	125	4 3	182	10 2
Bone dust ...	3	18	95	3 12	222	9 6
Bone siftings ...	4	23	105	2 15	174	8 2

*Allowing Rs. 9-4 per unit of nitrogen.

Having regard to what has been said of the relative efficiencies of these sources of phosphoric acid, it will be clear that at prices quoted, considerable saving can be effected by the use of ground mineral phosphates. These vary in efficiency, the general rules being that the softer rocks are more easily soluble in the soil than hard rocks and that the finer the grinding the greater will be the efficiency.

The presence of much iron and aluminium in a phosphatic manure is objectionable, since compounds of them with phosphoric acid are relatively insoluble.

Many naturally occurring phosphates contain limestone which is an advantage for use with green manures on acid soils.

All naturally occurring deposits of phosphatic rock are radio-active on account of a small content of uranium. It has been shown that radio-activity stimulates certain plant-cell activities, but trials with small quantities of radio-active materials as manure have given no increase in crop, while large quantities are actually harmful. No value can be assigned to radio-activity in a manure.

Notes on the phosphatic manures now on the market are appended.

Basic Slag.

A by-product of steel manufacture. Of very high availability, and still the best phosphatic manure for green crops on acid soils. Modern methods turn out a product of less value as manure than the old methods, and at present prices basic slag is being replaced by ground mineral phosphates even on grass land in Britain, where basic slag has proved of such enormous value.

Mineral Phosphates.

Radiophos.—A hard apatite (phosphate of lime) mixed with haematite (oxide of iron). Contains only very little carbonate of lime. Very finely ground.

Ground Singhbhum Phosphate.—An apatite similar to above, but most of the haematite has been removed by electro-magnets. Very finely ground.

Algerian Flour Phosphate.—No specimen has been examined. Phosphates from this source are usually fairly hard but contain little iron and aluminium, and some carbonate of lime.

Belgian Flour Phosphate.—A soft rock containing large quantities of carbonate of lime and very little iron or aluminium. Usually sold about as coarse as coarse sand. Efficiency could be improved by finer grinding.

Superphosphate is prepared from mineral phosphates by treatment with sulphuric acid, which renders the phosphoric acid soluble in water and therefore immediately available. For green crops on acid soils it is not as efficient as basic manures, unless applied together with lime. For direct application to tea it is probably the best phosphatic manure. It is expensive at present but useful for mixing with sulphate of ammonia for which purpose basic manures like basic slag and most mineral phosphates, are unsuitable.

Bone Products.

Steamed Bone Meal.—Of fair efficiency if finely ground; it should all pass a 3/16 inch mesh sieve. At present much too expensive for use with green crops, but often useful for mixtures. The steaming affects the value as manure very little, but renders safe from carrying diseases like anthrax.

Bone Dust usually contains some coarse particles, but the great bulk of it is very fine, and hence efficient. Not being steamed, is liable to carry disease.

Bone Siftings consist of large pieces of bone with adhering sinew. Cheap, but being coarse is of low immediate efficiency, and it is also unsterilized.

Potash.

The special function of potash in the soil is to delay maturity and stimulate the continued production of wood and leaf instead of flower. It is therefore of special value on sandy soils which are inclined to give early crop, but to close too early. Sands also are more commonly deficient in potash than soils containing much clay, since clay is usually derived from minerals rich in potash. On cut-back tea a sufficiency of potash is necessary to keep shoots from wooding up before thick enough.

Potash, also, on most crops has proved useful in reducing attack by diseases, and on tea, has certainly given results with fungus diseases of the stem and in several cases with mosquito blight.

For seed gardens it is usually necessary, because a sufficiency of potash is necessary for the filling of sound seed; though an excess would defer flowering, for which reason on tea grown for leaf, potash has proved useful for unpruned tea, and for China and Hybrid varieties, in which cases early flowering sometimes reduces the crop of leaf.

Selection of Potash Manures.—Since all the forms of potash used as manure are soluble in water, there is not much difference between different potash manures in efficiency. At Borbhetta muriate of potash has so far proved as efficient as other forms.

The following potash manures are now available on the Calcutta market.

	Nitrogen.	Potash.	Price per ton.	Unit cost.
	%	%	Rs.	Rs. As.
Muriate of Potash ...	...	50	135	2 11
Sulphate of Potash ...	...	50	180	3 10
Sylvinite	...	20	90	4 8
Nitrate of Potash ...	10	33	245	4 10*
" " ...	9½	30	140	5 1*

The first three are all derived from natural deposits occurring in Germany and Alsace, where they occur associated with

*Allowing Rs. 9-4 per unit of nitrogen.

magnesium salts. A lower grade salt, Kainit is also much used in Europe, but as this contains only about 12 per cent. potash, freight costs make its unit price in India too high. For a few soils deficient in magnesia it is occasionally useful to apply Kainit or Sylvinite for the sake of the magnesia present, but tea soils in North East India commonly contain too much magnesia naturally. Until recently, imported potash salts were expensive compared to the Indian produced nitrate of potash. At present the supply of nitrate of potash on the market is small, and such as is available is often of poor quality.

At prices quoted, muriate of potash is much cheaper than any other source of potash, and is at least as efficient as any other form, so that the selection of a potash manure at the present moment is a very simple matter.

Potash for tea manuring is practically always used as a constituent of a mixture containing nitrogen. Potash very rarely gives any significant increase in crop if used alone on tea, while its application to a green crop is not usually advised, since we do not want to delay maturity of the green crop but desire a big crop in the shortest possible time.

SOIL SURVEY NOTES.

Nowgong District.

BY

P. H. Carpenter and C. R. Harler.

The soils of the Nowgong district are, unlike those of the Dhunsiri district, all closely related. In Dhunsiri we have the heavier red soils on the Mikir slopes and the lighter ones laid down by the Brahmaputra. In Nowgong practically all the soils are of the heavier type and the lighter soils, such as occur at Jiajuri, came from this type by washing which carried off the clay and finer fractions and left the coarser particles at the foot of the hills.

Many of the gardens are put out on red banks which are separated from the hills by a depression in which the lighter type of soil is found. These detached banks resemble the red soils of the actual hill slopes.

The area round about the Misa Club appears to have been put down by the Kalang River or by some part of the Brahmaputra but the Misa garden soils are related to the Amluckie and Rangagora older, red deposits.

There is a bank, 20 to 30 feet high in places, along the Kalang River and it is only on the Gauhati side of this bank that the soil definitely looks as though it was new alluvium.

Most of the Nowgong soils are of the type 2, 3, 4, 5, 1, which is the common type on the south bank of the Brahmaputra and in Darrang. One noticeable feature of these soils is their shortage of coarse sand and the high content, 10 per cent. to 20 per cent., of clay. In this respect they differ from the Tezpur Red Bank soils which generally contain a fair percentage of

coarse sand rendering them open and easy to cultivate. Generally speaking the Nowgong soils are stiff and difficult to work.

At Kuturi, the first Nowgong garden coming from the Dhunsiri side, both red and black soils occur. The following types of soil are met :—

2, 3, 4, 5, 1 (2 examples)
2, 4, 3, 5, 1 (2 examples)
5, 2, 3, 4, 1.

The last example is the red soil, of course.

Koliabur with its out-garden Sonari is situated on the slopes of an isolated hill forming a headland into the Brahmaputra. The rock which forms the hill is a granite belonging to the Mikir Hill System. The rock is quarried by the River side and the *ghat* here is known as Silghat (*i.e.*, stone *ghat*).

The Koliabur soil is not so red and stiff as might be expected from the situation of the garden. It is of the type—

2, 3, 4, 5, 1.

At the foot of the hill by the river is a small area on which wheat and oats do well. The soil here is somewhat lighter than the red soil above but although it was put down directly from the river it is obviously affected by washings from the higher level. This soil shows a low acidity, indicating a new soil and explaining why wheat and oats thrive on it.

Seconee is put out on the end of a spur of the Mikir Hills and runs from the hills themselves across the level to the bank, below which is the bheel.

Although the red soil often crops out at Seconee, in the main the soil is light or silty even on the slopes themselves. The process of lightening by washing seems to have been going on.

On the actual hill slopes where the soil is red the type—

2, 1, 5, 3, 4

occurs, containing about equal quantities, 20 per cent., of coarse and fine sand and clay. Samples taken from other parts of the

garden and away from the hills where the soil is black or grey are typical of Nowgong—

2, 3, 4, 5, 1 (2 examples).

In both these samples the coarse sand is a negligible quantity.

The tea does well on the garden and as at Koliabur the hullah planted areas look particularly healthy. The general average yield for Nowgong is 8 maunds and Seconee is somewhat above this.

The out-garden, Amguri, is situated on a series of narrow strips of soil sent out from the hills. In various places there is obviously newer soil overlying the old soil and here the tea is poor. This area is interesting because, apparently, water recently flowed between the main range and the Kukrakata Hill and swept round this bank. The whole country side about here has been greatly altered by earthquakes and the disturbance of 1897 changed the bheel considerably.

A sample of the red soil showed the type—

2, 3, 5, 4, 1

with 20 per cent. of both silt and clay. This soil is obviously old and well weathered.

Sagmutia is round the other side of the spur from Seconee and is mostly on the flat although some of the sections are on the hill slopes. Several hullahs run into the lower sections and simplify drainage problems. The soil between the hullahs varies somewhat and carries the best tea near the hullah edge.

Two analyses are available. One, taken on the hill slopes, is quite red and of the type—

2, 3, 5, 4, 1

with the first three fractions all equal at 23 per cent. This is an old weathered soil.

Away from the hill a sandy silt of the type—

2, 3, 1, 4, 5

was observed, consisting mainly of fine sand and silt (both 28 per cent.) with only a small quantity of clay.

Much of Kellyden is put out on fingers of red soil which stretch down from the hills. Between these red banks are deep hullahs carrying heavy jungle which acts as a wind belt and is of great value during the early part of the year when hot dry winds are common. The tea on these sections looks particularly healthy.

At Misa the soil is red in places and it seems likely that this area only just escaped being completely covered by newer soil at some remote period.

The type predominating is—

2, 3, 4, 5, 1 (11 examples).

The type—

2, 1, 3, 5, 4

also occurs, and at Misa, on newer patches of soil, the type—

2, 1, 3, 4, 5

is met.

Amluckie and Rangagora are the two gardens furthest from the hills. Rangagora is a redder soil than Amluckie but both show very similar analyses. At Amluckie the types—

2, 3, 4, 5, 1
2, 3, 5, 4, 1 (2 examples)
3, 2, 5, 4, 1 (2 examples)

and at Rangagora—

2, 3, 5, 4, 1
3, 2, 5, 4, 1 (2 examples)

occur with about 12 per cent. clay. Both gardens are cut up by shallow hullahs.

At Salonah the types—

2, 3, 4, 5, 1 (2 examples)
3, 2, 5, 4, 1

occur, all three samples closely similar.

The tea here is suffering from lack of plant food like many of the older gardens.

At Rangamatti, which includes Old Salonah, Ghurali, Simona and Nonoi, the new areas are very good but the tea on the older areas is debilitated. On Old Salonah where the hullahs are shallow, the newer silt overlies the red soil. The following types were observed :—

On the hill slopes	2, 3, 4, 5, 1
Ghurali	2, 5, 3, 4, 1
Simona	2, 3, 4, 5, 1
Nonoi	2, 3, 4, 5, 1

Lengteng, Dejoo Valley and Anjokpani stand in a bay in the hills and have a better rainfall than is general in the district.

At Dejoo Valley the common type—

2, 3, 4, 5, 1

occurs as a red soil and the rare type—

2, 4, 5, 1, 3

as a grey soil, two very distinct soils of different origin.

At Anjokpani the type—

2, 3, 4, 5, 1

occurs.

At Loongsong the common type—

2, 3, 4, 5, 1 (3 examples)

occurs.

Jiajuri is a garden full of interest from the soil point of view. Most of the soil was laid down by rivers from the immediate vicinity and the whole of the bay in the hills is filled with this river silt from which the red soil protrudes occasionally.

The name Jiajuri signifies a " live stream " which may be interpreted as a stream which moves about or changes its course. Some of the soils are only faintly acid, a condition which has been observed with other soils newly laid down. These soils are often infertile for tea probably because of their slight acidity or alkalinity and also because, owing to their newness, they have not had time to collect a plentiful store of organic matter.

The older tea on this garden is debilitated but a re-planted area appears to be doing quite well. The newer tea is some of the best in the district.

The types—

1, 2, 3, 4, 5 (5 examples)
1, 2, 3, 5, 4 (2 examples)
1, 2, 5, 3, 4
2, 1, 3, 5, 4
3, 2, 5, 1, 4

Except for the last three, they are all new soils.

The Kondoli group of gardens includes Topojuri, Kondoli, Sukimbari and Rembeng.

Topojuri is a strip of tea on the lower slope of a hill. The soil is red in parts but has in many places been changed by washing. The type—

2, 3, 1, 4, 5

occurs.

Kondoli is a short distance from the hills and the soil consists of a deep sand of the type—

2, 3, 4, 5, 1.

At Sukimbari both red and black or grey soils occur. The black soil is of the type—

2, 3, 4, 1, 5

Rembeng runs from the hill flanks where the soil is red, through a dip where the soil resembles a bheel and then to a rise where the soil again changes to a black, fine sand. These divisions are represented by the types—

2, 1, 3, 5, 4
4, 3, 5, 2, 1
2, 3, 4, 5, 1

The loss on ignition (*i.e.*, organic matter) on the bheel soil is 11 per cent. This area carries vigorous tea.

Borpani which is geographically out of the Nowgong district gives a red soil of the type—

3, 2, 4, 5, 1

Representative examples from Jiajuri, Loongsong, Amluckie and Rangagora are given.

SOILS OF NOWGONG DISTRICT.

	Jiajuri.	Loongsong.	Amluckie.	Rangagora.
MECHANICAL ANALYSES—				
Coarse sand	41	4	8	7
Fine ,, ...	25	40	33	30
Silt	14	23	30	31
Fine silt	7	14	11	12
Clay	9	13	13	15
Loss on ignition ...	2·76	3·62	3·64	5·63
Soil Type	1. 2. 3. 5. 4	2. 3. 4. 5. 1	2. 3. 5. 4. 1	3. 2. 5. 4. 1
CHEMICAL ANALYSES—				
Grandeau Organic matter	1·10	2·02	1·41	1·87
Total Nitrogen ...	0·084	0·068	0·118	0·178
Available Potash ...	0·003	0·007	0·015	0·014
,, Phosphates ...	0·010	0·003	0·011	0·017
,, Lime ...	0·018	0·024	0·075	0·088

The manurial treatment of the soils in the Nowgong district follows lines similar to those suggested for the Dhunsiri soils. (See Quarterly Journal Part III, 1924, p. 149.)

THE INTERPRETATION OF MANURING EXPERIMENTS ON TEA.

BY

N. M. MACGREGOR.

Although a certain amount of information regarding the requirements of a soil may be obtained by studying the mechanical and chemical analysis, such information is necessarily very limited chiefly because chemical methods do not measure with any accuracy the food which is available to the plant. Chemical analyses can only be translated in the light of practical experiments but here again little reliable information is to be had with regard to tea.

It is for instance known that an application of nitrogen in a tea soil will in most instances produce an increase in crop, but the optimum quantity to apply and the best form in which to apply it will depend on the nature of the soil and can only be found by experiment.

With regard to the other two important plant foods, potash and phosphoric acid, very little knowledge indeed has been obtained by direct experiment on tea soils.

In selecting a block of tea for experiment, we have first to choose plants in such a state that great variation in yield due to factors other than manuring may not be expected. For example with either immature young tea, or with tea recently cut back, the yield increases so quickly that the small increase due to manuring is relatively small and difficult to detect. In any case mature tea is the better subject for experiment since it occupies the greatest portion of the area of most gardens, and one cannot be certain that results obtained on young tea would be true also for old tea.

With single plot experiments there is always the possibility that an increase or decrease in yield may be due to some agency other than the fertilizer applied and unless the experiment is repeated two or three times there is no indication as to the accuracy of the result.

The experiments quoted below have only been in progress for two years and it cannot be expected that a great deal of information will have been acquired. For this reason it is proposed to treat the subject rather from the point of view of the interpretation of results than from the results themselves.

In every case the trials are repeated in triplicate and the plots, $\frac{1}{10}$th of an acre in area, are 6 bushes wide. This is a convenient size of plot as it can if necessary be plucked by one woman in a morning. The shape is convenient as the whole set of plots can be arranged parallel and near to a road whilst patches of bad soil are less likely to interfere and make one plot vary greatly from another than would be the case if square plots were used.

In 1922 the plots were staked out and the leaf weighed every seven days to ascertain the initial fertility—that is, the initial differences existing between the plots before being individually manured.

Initial Fertility.

In experiments with annual crops it has not been found that small differences in soil fertility previous to a manurial experiment have much effect on the result of the trial, because the germination of a seed is so entirely dependent upon the soil and weather conditions prevailing at the time of sowing. An area of soil which shows a poor fertility in a year of heavy rainfall may in the following year possess average fertility by reason of a smaller or better distributed rainfall.

In the case of a tea bush the combined effect of many successive years masks the climatic variations from year to year and the resulting bush is, in comparison with its neighbours, a fair indication of the fertility of the soil on which it grows.

The ideal piece of tea for experimental purposes would be an area which could be divided up into the required number of plots all giving equal yields. In practice this is never possible, and in spite of every care and consideration having been taken in choosing the areas now under experiment so that shade trees, drains, slopes and the general health of the bushes were as uniform as possible, it was disappointing to find that a variation of as much as 20 per cent. frequently existed in the mean yields of the plot-sets. The term plot-set is used to denote those three plots which receive the same manurial treatment. A difference as great as 20 per cent. would, in most cases, entirely mask the results of any manures which might subsequently be added during the first two or three years.

As an example of this the figures of an experiment carried out on ten-year old tea, pruned to two or three inches of new wood each successive year, may be quoted. The initial fertilities as represented by the total year's yield, were as follows :—

Plot letter	A.	B.	C.	D.	E.	F.
Series 1 ...	174	163	129	127	145	134
Series 2 ...	120	116	157	166	99	129
Series 3 ...	123	106	93	113	102	90

The average for each plot-set is—

139 128 127 135 115 118 (i)

Throughout the experiments detailed below, the A plots have been taken as the check plots. Then for E to show an increase on A, it will be necessary for it to give a comparative increase of more than 24 lbs. which is over 20 per cent. on the yield.

In the following year (1923) C, D, E and F were manured with increasing quantities of nitrogen whilst all but the check plot received equal dressings of potash and phospheric acid. The resulting yields given by these plots were then as follows :—

Plot letter	A.	B.	C.	D.	E.	F.
Series 1 ...	201	193	188	180	227	246
Series 2 ...	133	150	197	232	152	200
Series 3 ...	136	141	115	165	165	160

The average for each plot-set is—

157 161 167 192 181 202 (ii)

It happens in this case that the increase produced by the nitrogenous manure was so great that it has overcome the initial difference which existed between E and A, nevertheless the crop shown by plot E breaks the steady increase from A to F and the apparent depression at E could not be explained without the initial fertility records.

The initial fertility curve and the curve showing the actual yields after manuring are shown on curve (i) and (ii) respectively in the diagrams.

The Correction of Results.

In order to get a true measure of the effect of manures on these plots it is obvious that consideration must be given to the initial yields. However, the best method of estimating the influence of this yield is not easy to find. It is conceivable that the result of manuring might be an additive one. In that case the following correction to the plot-set E yield might be applied. Thus, in the initial fertility year the check plots A gave an average of 139 lbs. whilst the average of the E plots was 115 lbs. Here the A plot-set has a start of 24 lbs. on the E plot-set and for a true comparison of the yield after manuring this 24 lbs. start should be added to the crop given by the E plot-set. Then we say that the corrected yield for the E plot-set is 181 + 24 = 205 lbs.

Similarly if all the plots are corrected the following results are obtained :—

A.	B.	C.	D.	E.	F.
157	172	179	196	205	223

A, being the check, does not change of course. It will be noticed that a steady increase is now shown from A to F as the amount of fertilizer increases. These values are shown on curve (iii) of the diagram.

The difference in the initial yields are in the main due to the size and health of the bushes and only to a small extent to the

actual plant food or soil condition maintaining during the experiment. It cannot therefore be expected that a plot on which the bushes are small will give the same numerical increase as one on which all the bushes are large; for, with a small bush, the root development is such that only a small part of the manures added can be assimilated by the plant.

It is more reasonable to expect that the increase from manuring will be *proportional* to the initial fertilities and that for a given plot with a given manure a definite percentage increase will be obtained and not a purely additional one.

This correction is made by expressing the manured yield of each plot as a percentage of the initial yield. Considering again the E plots we see that in the initial fertility year they gave an average yield of 115 lbs. and in the manured year an average of 181 lbs. of leaf. The manured yield therefore was 157.4 per cent. of the initial yield.

Similarly for all the plot-sets the percentage increases in the second year were as follows :—

A.	B.	C.	D.	E.	F.
112	127	132	142	157	172

The values show a slightly smoother gradation than when the additive increase were considered. Curve (iv) illustrates these values.

Of curves (iii) and (iv) we must determine which gives the truest interpretation of the experimental result without resorting to the dangerous method of choosing that curve which is most in line with expectations. This may be done by finding out which method gives the lowest percentage probable errors, provided as is here the case that each experiment has been repeated at least three times.

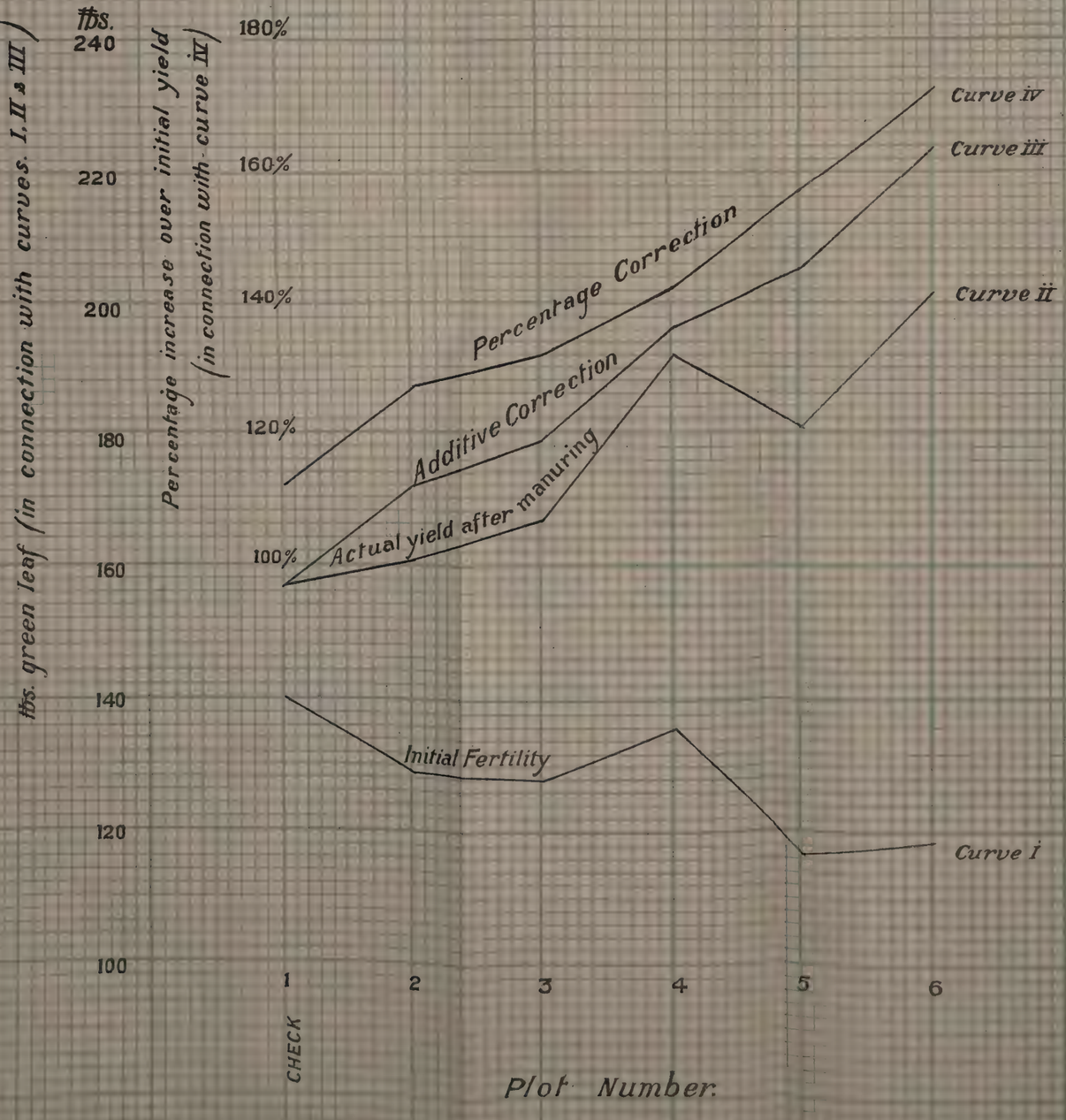
Probable Error.

When an experiment is repeated a sufficient number of times the probable error of the mean result (*PEm*) may be found from the formula :—

$$PEm = \cdot 67 \sqrt{\frac{S\, d^2}{n\ (n-1)}}$$

Diagram.

Showing the actual increase in crop return due to manuring and the interpretation of this increase with regard to initial fertility.



where $S\,d^2$ is equal to the sum of the squares of the differences of each individual result in a given plot-set from the mean of that plot-set, and n is equal to the number of times that the experiment is repeated.

If however, as in the case considered, the experiment is carried out only in triplicate it is doubtful whether the figure arrived at from the above equation is of any real value as it stands; but we may find that the average percentage *PEm* of a plot-set is considerably lower when one method is used for correcting results than another, of, if little or no correlation exists between the initial fertility and the manured yield, then we shall find that the *PEm* figure is raised and not lowered by any correction.

Thus in the experiment already quoted we get the following result by considering the actual yields given by the check plots in 1923.

The actual yields are 201, 133 and 136 lbs. and the mean of these three values is 157. Then—

Actual yields.	Difference from mean (d).	Square of difference (d^2).
201	44	1,936
133	24	576
136	21	441
Mean = 157	Sum of d^2 ($S\,d^2$) =	2,953

In the equation above we may substitute 3 for n, then $n\,(n\text{-}1)$ becomes $3 \times 2 = 6$. We are now able to solve the equation and we find that—

$$PEm = \cdot 67 \times \sqrt{\frac{2953}{6}} = 14\cdot 9$$

Then since the mean of the actual yields was 157 and the probable error of this figure is 14.9, the percentage probable error is 9.5.

Similarly for all the plot-sets the following percentage probable errors are obtained.

	A.	B.	C.	D.	E.	F.
PEm %	9.5	6.6	10.4	7.0	8.6	8.2

So that the average *PEm* percentage for the uncorrected curve is 8.4. This means that any value of the series is liable to be on the average incorrect by 8.4 per cent.

If we consider the values given by the additively corrected yields the probable error of the mean is 2.52 per cent. whilst that of the percentage corrected curves is only 1.73 per cent. These last figures hence are the truest of the three sets.

In another experiment conducted on the same lines as the above, the plots were manured with increasing quantities of potash. The results were not in accordance with expectation in that the curve presented a broken appearance and did not show a steady rise or fall with increasing quantities of potash applied as manure.

On examination of the probable errors it was found that the corrected results were less reliable than the uncorrected ones, the reason being that the tea had received a heavy prune at the end of the initial fertility year and the factors influencing the speed with which the bushes came away were not the same as those which caused the initial differences in yield between the various plots. Therefore tea which is under experiment should only be top pruned so that the frame of the bush is preserved as far as is possible.

The point which it is desired to emphasize is that any corrections may be applied which tend to lower the probable error of the experiment provided such corrections hold for the whole experiment.

In both the above experiments the applications of manure were such that a smooth curve might be predicted and we should not be liable to any great error if we choose that curve which appears to be the smoother. But where it is desired to find out in what form a plant food is most beneficial, the form of the curve cannot be anticipated and the result deduced from the yields themselves may be entirely the reverse of those shown by a curve corrected for initial fertilities.

Thus an experiment was made using five different forms of nitrogenous fertilizer, each plot receiving the same amount of

Nitrogen, Potash and Phosphate. The Nitrogen being applied as follows :—

Plot-Set.	A.	B.	C.	D.	E.	F.
	No nitrogen	Nitrolim.	Ammonium Sulphate.	Oil-cake.	Fish guano.	Anima meal.

The yields from these plot-sets in 1923, the manured year, were :—

lbs. of leaf—	285	316	300	341	316	295

It is seen that the greatest yield is given by the oilcake plot and the smallest by the animal meal.

When these yields are expressed as percentage of the corresponding initial fertility yields the order of efficiency is entirely changed and the figures obtained are as follows :—

A.	B.	C.	D.	E.	F.
149%	156%	160%	161%	161%	166%

The probable error of the experiment deduced from the yields is 4.73 per cent. whilst that deduced from the percentage figures is only 1.8 per cent. A truer interpretation, therefore, is shown by the corrected curve than by the curve plotted from the yields themselves. Interpreted in this way it appears that animal meal has produced the biggest relative increase, although the animal meal plot is still giving less crop than any other manured plot. The average increase produced by one year's manuring is however only 8 per cent., an increase too small to be accurately measured when three plots only are used for each experiment, so that the actual increase calculated by the above method can only be regarded as approximate.

It is certain however that these figures are a much truer index to the action of the manures then the crop yields themselves uncorrected for initial fertility.

NOTES.

How to take a Soil Sample.

Soil samples are best taken with an ordinary wood boring auger fixed at the end of a rod or pipe about 3 feet long and fitted with a cross piece of wood at the top. A patch of land about 20 yards square should be selected as representing the average of a section and from this area about five or more borings should be taken from evenly distributed points.

To allow comparison with other soils the surface soil is defined as the top nine inches and the auger should be screwed into this depth, and withdrawn by a straight pull. The adhering soil is scraped off into a box. The mixture of the borings is a representative sample. About a pound weight of soil is required.

If the subsoil is markedly different in texture from the surface soil, a sample of the subsoil also should be taken. For example a sample of soil between 15 inches and 24 inches depth may be required. Having taken out the 9 inches of the soil from the first boring, the clean auger should be screwed down to 15 inches from the surface and again withdrawn by a straight pull. This leaves a hole free of soil to 15 inches depth. The cleaned auger inserted into the same hole should now be screwed in till the point is 24 inches from the surface. The soil withdrawn by the next pull is the subsoil between the required limits of depth.

If an auger is not available, a good average sample may be made as follows. A clean cut with the hoe is made into the soil and from the smooth face of the hole thus made, soil to a depth of nine inches is scraped. It is convenient to use a cigarette tin as a scraper. A composite sample from spots, distributed as suggested above, should be made.

Rotation of Manuring.

When making suggestions regarding manurial rotations for tea gardens, in addition to the chemical and mechanical analyses

of the soils and notes on their treatment, yields and situations the following information is necessary :—

(*a*) The area of the garden which can be put under a quick growing green crop, *e.g.*, cowpeas, and that which can be put under a semi-permanent green crop, *e.g.*, Boga medeloa, with estimates of costs.

(*b*) The area which can be cattle manured at the rate of 5 tons per acre, and the estimated cost of such manuring.

(*c*) The price per maund of locally obtainable oilcake.

(*d*) Expenditure allowed per acre, exclusive of application.

The information enables us to make use of local manure which is often the cheapest.

The Distribution of Blister Blight (*Exobasidium Vexans.*)

In another article in this journal, Tea in Ceylon, reference is made to the law prohibiting the import of Tea seed from North East India into Ceylon. The reason for this restriction is the possibility of the introduction with the seed of the fungus which causes Blister blight. So far it has been found impossible to disinfect tea seed without sterilising the seed itself and further we have no proof that this fungus cannot be carried in the seed. It is however important to note that at least half the area of North East India has always been quite free from this disease. Between these areas and those infected with the blight there has always been a free interchange of seed. In spite of the fact that every year seed is distributed from infected gardens to uninfected districts, the latter remain uninfected.

During this season a large quantity of seed has been exported to Africa and other countries. Representative samples of each consignment have been carefully examined by this department. More than 13,000 seeds have been opened and examined in the last year. These seeds were obtained from

seed gardens situated in every district. None of the seeds contained a fungus of the same order, the Basidiomycetes, as Exobasidium. The only fungus found, likely to be pathogenic, was a species of *Fusarium*. This was only found in two seeds. I think it is safe to assume that there is little probability of seed being a factor in the distribution of Blister blight. At the same time it is only fair to point out that there is no scientific proof that it cannot be carried in seed nor is it possible to obtain scientific proof of this matter.

A. C. T.

Stem Disease caused by Corticium SP.

During the last season a considerable increase in damage due to stem diseases has been noticed. This is probably due to the abnormal climatic conditions early in the last year. The most serious damage has been caused by a species of *Corticium* resembling that which causes Pink disease. This fungus attacks the bark causing it to whiten and become soft. The attack usually starts at a fork on red wood. It then gradually extends from the red wood to the older wood. After a time pinkish patches may be noticed, sometimes on small twigs, but frequently on the larger twigs just below forks. These pinkish patches are the fruiting stage of the fungus. Under favourable conditions, *e.g.*, a damp atmosphere, this disease can spread with remarkable rapidity. A few bushes close beside the laboratory were infected from diseased plants which came from the Terai. Three months later most of the tea at Tocklai had become infected.

The fungus does not attack the living tissues on vigorous twigs but it has been observed to do so on less vigorous ones. In the treatment of this disease pruning is very important. The infected areas should be very carefully pruned and all dead snags and moribund shoots removed. As the fungus can survive on dead wood for some time it is necessary to burn the prunings. The bushes should then be sprayed thoroughly with

lime sulphur double the strength normally used in the rains. With the stock solution recommended by this department a dilution of 1 in 3 is suitable. For young tea 1 in 4 may be used. Seed trees should be sprayed with 2 per cent. Burgundy mixture with resin adhesive added. The formula for this solution is given below. In spraying for this disease special attention must be paid to the thorough wetting of the forks.

There are a number of species of *Corticium* attacking tea the commonest species is *Corticium invisum,* the cause of Black Rot. This has also been more prevalent during the last season. All the species are being carefully investigated and it will be possible to publish a more or less complete report of them soon.

To prepare lime sulphur solution take 20 lbs. quicklime, 22½ lbs. sulphur and 50 gallons water.

The lime should be put into a drum of 50 gallon capacity and slaked by adding water gradually. When it is fully slaked, add about 30 gallons of water, and bring to the boil. When it is boiling add the sulphur gradually, stirring vigorously during the whole time, and when all the sulphur has been added pour in boiling water to the 50 gallons mark. Boil for an hour longer, keeping the volume at 50 gallons by adding boiling water. This gives the stock solution, which, when cool, may be diluted with the volumes of water given above and used immediately.

Care must be used in its preparation, and if it be desired to keep the stock solution, it must be stored in full, air-tight vessels, or, if the vessel is not full, with a layer of oil on the surface.

Lime sulphur solution should not be stored in copper vessels, or sprayed on to the bushes from copper spraying machines. Great care must be taken to see that all spraying machines are thoroughly cleaned out after use.

To prepare 50 gallons 2 per cent. Burgundy mixture dissolve 10 lbs. of crystallised copper sulphate by suspending it in a piece of sacking in two and half gallons of warm water (if

required immediately). If cold water is used the copper sulphate may be left to dissolve overnight.

In the same way dissolve 4.6 lbs. of soda ash.

Add the soda ash solution gradually to the copper sulphate solution, stirring all the time, until the mixture becomes neutral. This can be tested with litmus paper. The solution should be either neutral or very slightly alkaline but never acid. It is necessary to prepare this mixture in wooden, copper or earthen vessels. The soda ash attacks iron a little but not sufficiently to make any serious change in the solution. The solutions should be allowed to cool before they are mixed.

The addition of the above mixtures will make 5 gallons concentrated mixture, which, when diluted to 50 gallons will be 2 per cent. Burgundy mixture.

To prepare resin adhesive for use with Burgundy mixture take 1lb. washing soda, 2 lbs. resin (common resin or colophony) and 1 gallon water.

Boil the water, then add the soda. When dissolved, add the resin and boil for about an hour, stirring continually.

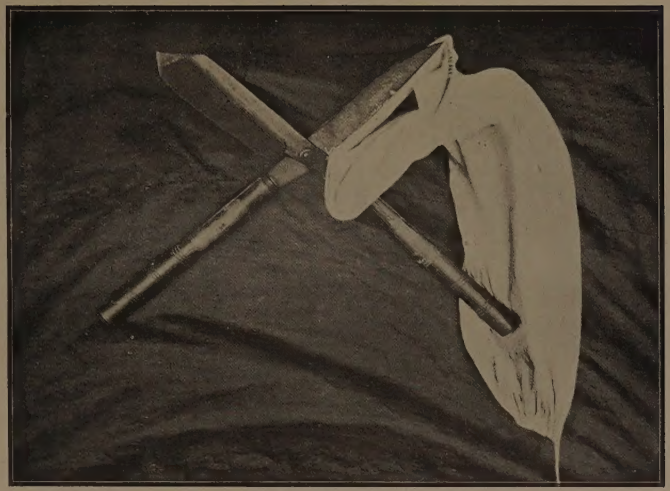
Add this, when cool, to Burgundy mixture prepared as above, at the rate of one gallon to the every 24 gallons.

The department will be pleased to receive specimens of suspected bushes. Full particulars of distribution, extent of damage, etc., should accompany the specimens.

A. C. T.

Plucking Scissors used in Japan.

The illustration shows the type of plucking scissors used at present in Japanese tea gardens. The tea farmer in Japan was at first opposed to the use of scissors for plucking, but the high cost of labour forced him to adopt this method. With hand plucking, 25 to 30 lbs. leaf per day is a fair task in Japan but with scissors from 200 to 250 lbs. is obtained by a woman. A maximum of 432 lbs. has been plucked in a day and the average task for a man is 300 lbs.



Plucking Scissors used in Japan.

The blades of the scissors are about eight inches long. One blade is fitted with a scoop and the other blade with a long open-ended bag, the mouth of which is kept open by a thick wire loop fixed to the blade. The end of the bag is held in the right hand with the right handle of the scissors and when the bag is filled it is emptied into a basket.

The ease of plucking by this method will be appreciated when it is understood that the Japanese tea bush resembles a box hedge and the flush is one continuous, thick, even spread of leaf. Fine leaf, containing little stalk, is obtained by plucking scissors.

Attempts to use the plucking scissors in Assam have not met with any success as yet for the amount of leaf per unit area in North East India is very small and would only average about ½ oz. of leaf from each bush per plucking, reckoning on a 10 maunds *pucca* tea crop on a 3,000 bush per acre garden, with 30 pluckings in the season. By changing pruning methods and plucking periods however it is possible that scissors plucking may become practicable in India. In Japan it is found that real success is only obtained after the bushes have been plucked into shape by scissors for three years.

C. R. H.

PROGRAMME OF TOUR—1925.

Touring.—The following is the touring programme that it is hoped to be able to carry out during the year :—

Months.	P. H. Carpenter.	H. R. Cooper.	C. R. Harler.	C. J. Harrison.
January	Dooars	.....	Golaghat	.....
February	.....	Moran	.....	.....
March	N. W. Cachar and Calcutta	.....	Boroi and N. Lakhimpore	.....
April	.....	Home leave	Dooars	.....
May	Sonari and Nazira	,,	,,	Doom Dooma
June	.....	,,	,,	.....
July	Tezpur and Calcutta	,,	,,	.....
August	Mangaldai	,,	,,	.....
September	.....	,,	Darjeeling	.....
October	Balisera and Calcutta	...	Luskerpore and Chittagong	.....
November	.....	Bishnath and Behali	.....	.....
December	.....	...	.....	.....

The Entomologist and Mycologist will tour as the investigations which they are carrying on may necessitate.

The Mycological Programme indicates the probable touring of Mr. Tunstall during the year.

Mr. Andrews will probably tour in the Brahmaputra Valley but the itinerary of his tours has not yet been definitely made out.